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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

MARCH, 1924

THE "GROMET" SHEEP
CHRISTIAN WRIEDT

BARRO COLORADO ISLAND LABORATORY
DAVID FAIRCHILD

INTENSIFIED ALEURONE COLORS IN MAIZE
A. C. FRASER

BETTERING THE BIRTH RATES
ERNEST DODGE

VARIATIONS IN TARWEEDS
E. B. BABCOCK

PUBLISHED BY THE
AMERICAN·GENETIC·ASSOCIATION
BALTIMORE, MD. AND WASHINGTON, D.C.

Volume XV Number 3

In Future Numbers

The Ancestry of the Prince of Wales, by Mrs. O. A. Merritt Hawkes, will present many interesting facts regarding human inbreeding, as exemplified by the Royal Families of Europe. (With 10 pages of illustrations and charts.)

Miss Anne Tracey will tell of the **Origin of the Shepherd Dog,** the breed often erroneously called the "Police Dog." Many statements have appeared recently that this breed was produced by a wolf-dog cross, and an authoritative account of its origin, by the Secretary of the Shepherd Dog Club of America, should be particularly welcome at this time. (With 14 illustrations.)

The possibilities of two new fruits will be discussed in early numbers by George Darrow. One of these, the **American Cranberrybush,** thrives farther north than other small fruits, and should also replace the currant in regions threatened by white pine blister rust. **The Chinese Bush Cherry,** which flourishes in cold and arid regions where the European cherry will not grow, is the subject of the second article. (6 illustrations.)

In an early number will appear the first of a series of articles by A. F. Blakeslee and John Belling on **Mutations in the Jimson Weed.** In this will be described forms having every appearance of being new species, in which the changes can definitely be traced to chromosome behavior. (With 7 illustrations.)

A note on a **"Cretin" Calf** at the Oklahoma Experiment Station will appear shortly. The authors are W. A. Craft and H. W. Orr.

A New Breed of Poultry, especially suited to tropical conditions, is being developed at the University of the Philippines. F. M. Fronda will tell of the origin of the breed, which is known as the "Cantonese." (Illustrated.)

The

Journal of Heredity

VOL. XV, NO. 3 MARCH, 1924

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The JOURNAL OF HEREDITY is published monthly by the

AMERICAN GENETIC ASSOCIATION

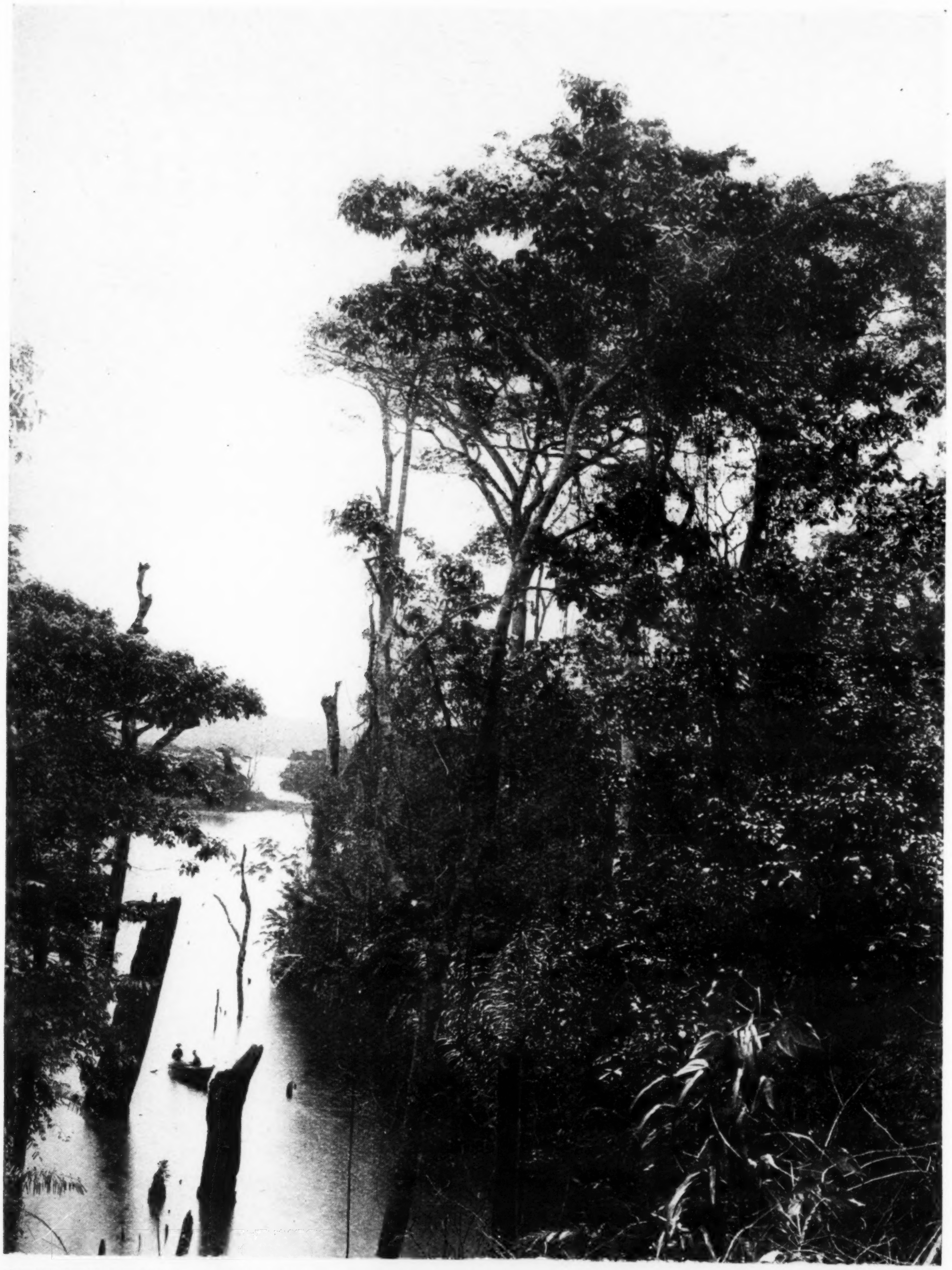
At 1918-32 Harford Avenue, Baltimore, Md., and
Victor Building, Washington, D. C.

Address communications regarding editorial matters and the business management of the Association to Room 306, Victor Building, Washington, D. C.

Entered as second class matter February 24, 1923, at the post office at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized December 20, 1918. Contents copyrighted 1924 by the American Genetic Association. .Reproduction of articles or parts of articles permitted only upon request, for a proper purpose, and provided due credit is given to author and to the JOURNAL OF HEREDITY, Washington, D. C.

Date of Issue of This Number, May 17, 1924

$3.50 a Year, 35c the Copy



PENETRATING INTO THE REAL JUNGLE ON BARRO COLORADO ISLAND

When the dam across the valley of the Chagres River was finished and the waters let into the great valleys to form what is now Gatun Lake, in the Panama Canal Zone, there occurred "The Great Flood" for the jungle beasts inhabiting those valleys. One can imagine the thousands of 'treks' to higher ground that occurred with the rising of the waters, as the Jungle Folk from all around took refuge on the newly formed islands. Probably never before has such a collection of wild animals been held prisoners as are found on the largest of these "artificial" islands, on which the jungle laboratory is located. From the newly erected laboratory on Barro Colorado Island, one gets this rather restricted view of Gatun Lake. (Frontispiece.)

BARRO COLORADO ISLAND LABORATORY

In the Rain Forest Jungle of Panama, on an Island in Gatun Lake, Conducted by the Institute for Research in Tropical America

DAVID FAIRCHILD

INSPIRATION to go ahead into the maze of phenomena surounding every worker in Genetics is quite as important as are the tools with which to go ahead. To a close student of temperate zone plants and animals what can be more inspiring than a glimpse into a tropical jungle? The wealth of form, the speed of growth, the parasites living upon parasites, the interdependence of insects and plants, the longer period of flowering that makes the spring last for several months, and the brief phases of leaf-fall, shortening autumn to a matter of days, make the tropics seem like another world. For a good many years I have spent my summers in Nova Scotia and my winters and springs in Southern Florida. It has been my good fortune to be a good deal in the tropics too, and I cannot agree with those who find so much to study where they are that they think it a waste of time to make a complete change of environment. One can be a spectator of thrilling events in all latitudes, and it is not hard to imagine when sitting beside some cool brook in Nova Scotia that no place could be more full of life than the brook beneath ones feet. Let the student of life in the temperate zone once follow a newly cut trail through a forest in the dripping tropics and if it does not convince him that he was mistaken and give him a new outlook upon the world of living organisms, it will be because he is too sensitive to the humidity and heat or too wet with perspiration to care what he sees.

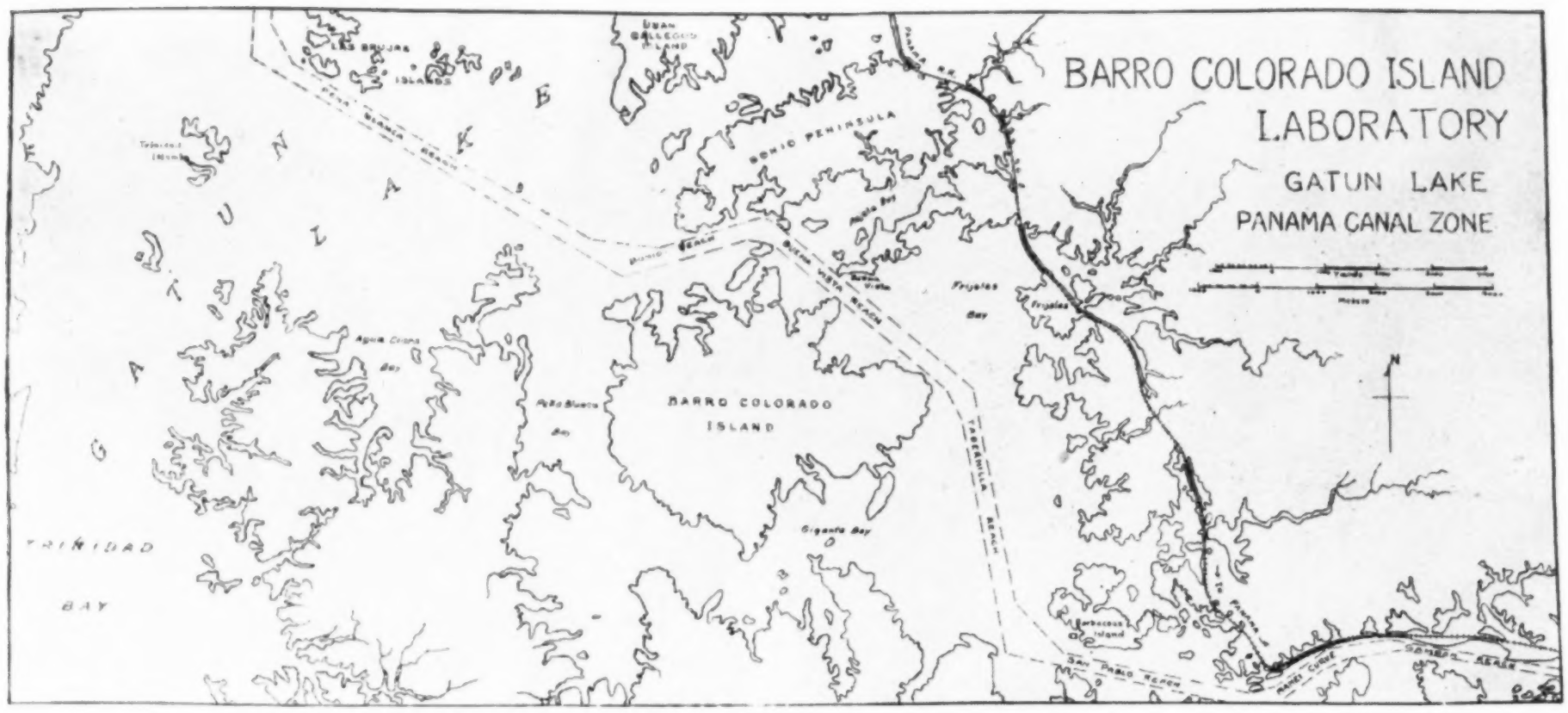
The science of Genetics, like any science of living things, must be all-embracing in its generalization, and I have become profoundly suspicious of generalizations made from the narrow viewpoint of a laboratory table, a botanic garden in northern latitudes, or a desert laboratory among the cacti, providing they are made by one who has never seen the mother liquor, so to speak, from which the plants of the world have come—the myriad of plants which compose the jungle of the tropics.

Take the single phenomenon of leaf-fall. In the northern latitudes we cannot disassociate it from the autumn phenomena of cold weather and frosts. Trees drop their leaves in the tropics, and become as bare as oaks in a winter landscape, but inside of a week they are covered with the bright fresh green leaves of spring. The seasons of autumn, winter and spring have passed before your eyes in ten days' time.

Consider the phenomena of parasitism. In the jungle there are few solid stands of a single species of plant, as there are in temperate regions. Everywhere one sees a wide diversity of plants with diseases and insects inhabiting and apparently consuming them, but the luxuriance of the plants continues and the worst parasites seem to fall a prey to their own enemies, so that the ebb and flow of epidemics of parasites comes to be looked upon as a matter of course. At almost every step of the way through a jungle the question which comes uppermost is "how long will it be before some parasitic insect which has found a favorable food

THE SKYLINE OF BARRO COLORADO ISLAND

FIGURE 1. This gives a general view of the island as it appears from some distance off shore. So dense is the forest covering that it is difficult to realize that the highest point on the island is 537 feet above sea level.



BARRO COLORADO ISLAND IN GATUN LAKE

FIGURE 2. Barro Colorado is the largest island in the artificial lake through which all steamers pass on their way across the Isthmus of Panama. The island lies only about two miles from the Panama Railway, and in sight of passing steamers. Its area is about six square miles and upon it is a hill 500 feet high. This is an ideal spot for a jungle laboratory because the concentration of animal life, brought about by the rising waters of Gatun Lake, has been preserved from destruction and made available for study by Governor Morrow, of Panama.

plant and is increasing rapidly at the plant's expense, will be preyed on by its enemy and held in check?"

The survival of species through their immunity to destructive diseases, and a study of the causes which furnish that immunity, are problems whose solution is destined to influence human life most profoundly. In the tropical jungles I believe they may be solved—at least in some great brain the thought may be aroused which will lead to the generalization necessary for their solution.

It is perhaps significant and worth recalling that the greatest biological generalization of our time was made independently by two great minds, both of which had felt the intellectual thrill of the tropical jungle: Darwin and Wallace. When one reads the works of Bates and Belt, Humboldt and Fritz Mueller, Kingsley and many others, it is hard not to conclude that there was some connection between the stirring biological environment which surrounded them and the brilliancy of their generalizations. We are prone to blame the tropics for the poor intellectual showing of tropical peoples, forgetting that a visit to the tropics is a very different thing from a lifetime spent in them. The latter carries with it all the dragging down of long association with peoples whose presence consumes one's attention but seldom stimulates thought; except as a race problem stimulates it.

Genetics presupposes appreciation of form. Plant and animal breeders revel in the changes of form of the plants and animals they breed, and pride themselves upon the ability they possess to hold in their memories accurate pictures of forms which they have seen. Should not any experiences which stimulate the activity of this form memory carry with them lasting effects which will tend to increase creative thought and equip the thinker to go deeper into the mysteries of the untracked intellectual world of heredity?

We must remember that it is not the mass of obvious or near-obvious data which we collect that advances our science most, but the real discoveries that are made. Is it not

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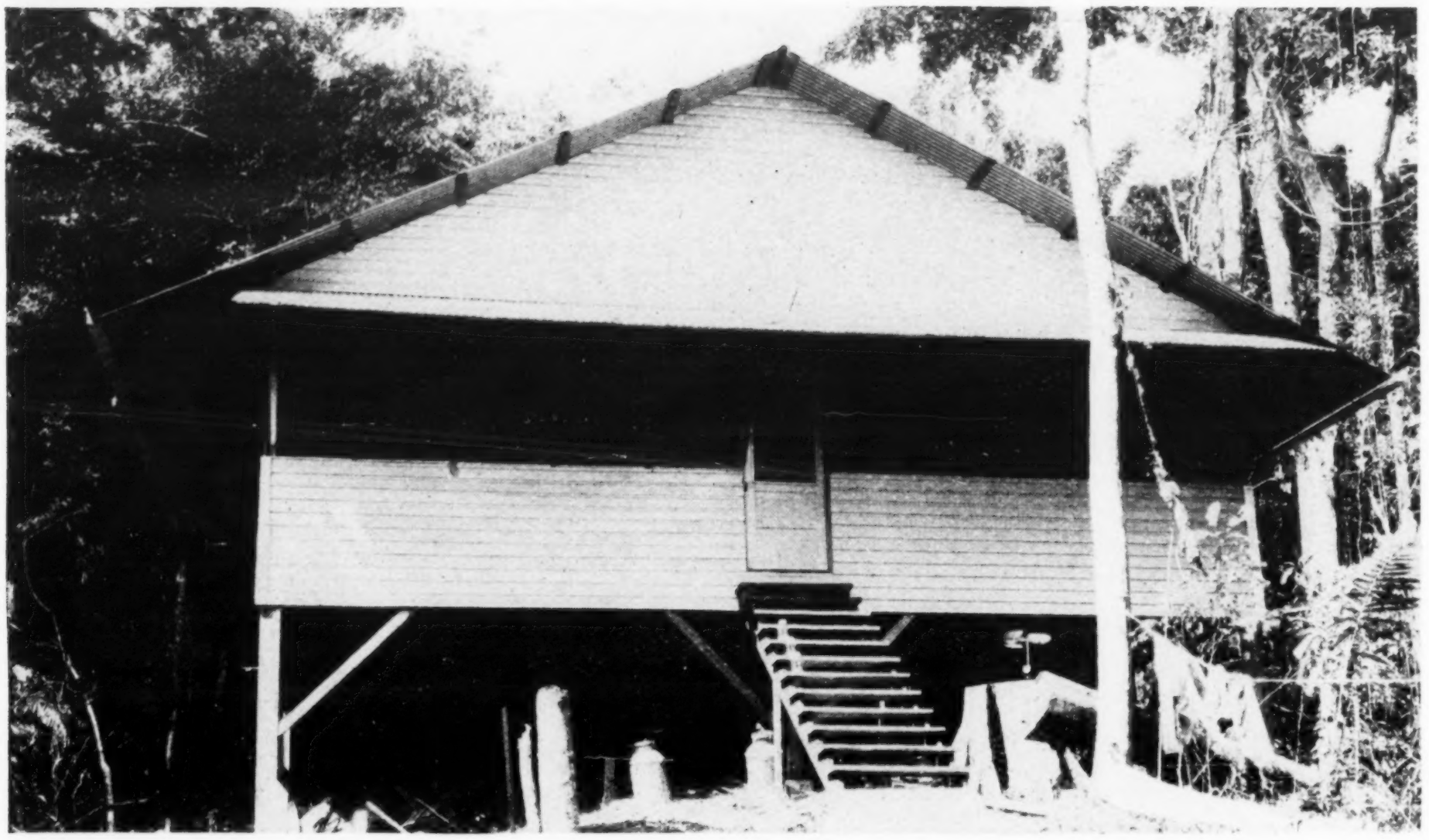
difficult to realize that the highest



THE JUNGLE LABORATORY ON BARRO COLORADO ISLAND

FIGURE 3. The deep overhang on all four sides of the roof prevents tropical downpours of rain from driving in. From the carefully screened porches many interesting observations of the wild life of the jungle can be made, incidental to the microscopical work which is already being done there.

THE LANDING AT BARRO COLORADO

FIGURE 4. The stairway leads to the jungle laboratory, which is more than 200 feet above the level of the lake, and hidden from view by the trees and palms. An Indian Cayuka is moored at the landing.

A NEWLY CUT JUNGLE TRAIL ON BARRO COLORADO

FIGURE 5. Really to see the life of a tropical jungle, trails are indispensable, for only while traveling along them can one glimpse into the impenetrable thickets of which the jungle is composed.

THE BEGINNING OF THE ISLAND LABORATORY

FIGURE 6. This shows all that there was of civilization on Barro Colorado when the biologists arrived to erect a jungle laboratory. Dr. Thomas Barbour, Dr. Edward Wigglesworth and Mr. Brooks aided in the selection of the site for the laboratory. The forest around them is made up of more than 2,000 species of flowering plants, and living in it are found four species of monkeys, several species of opossum, sloths, ant eaters, armadillo, deer, tapir, agouti, squirrel, rabbit, raccoon, coati, ocelot and bats, a host of strange reptiles, and a universe of insect life and fungi.

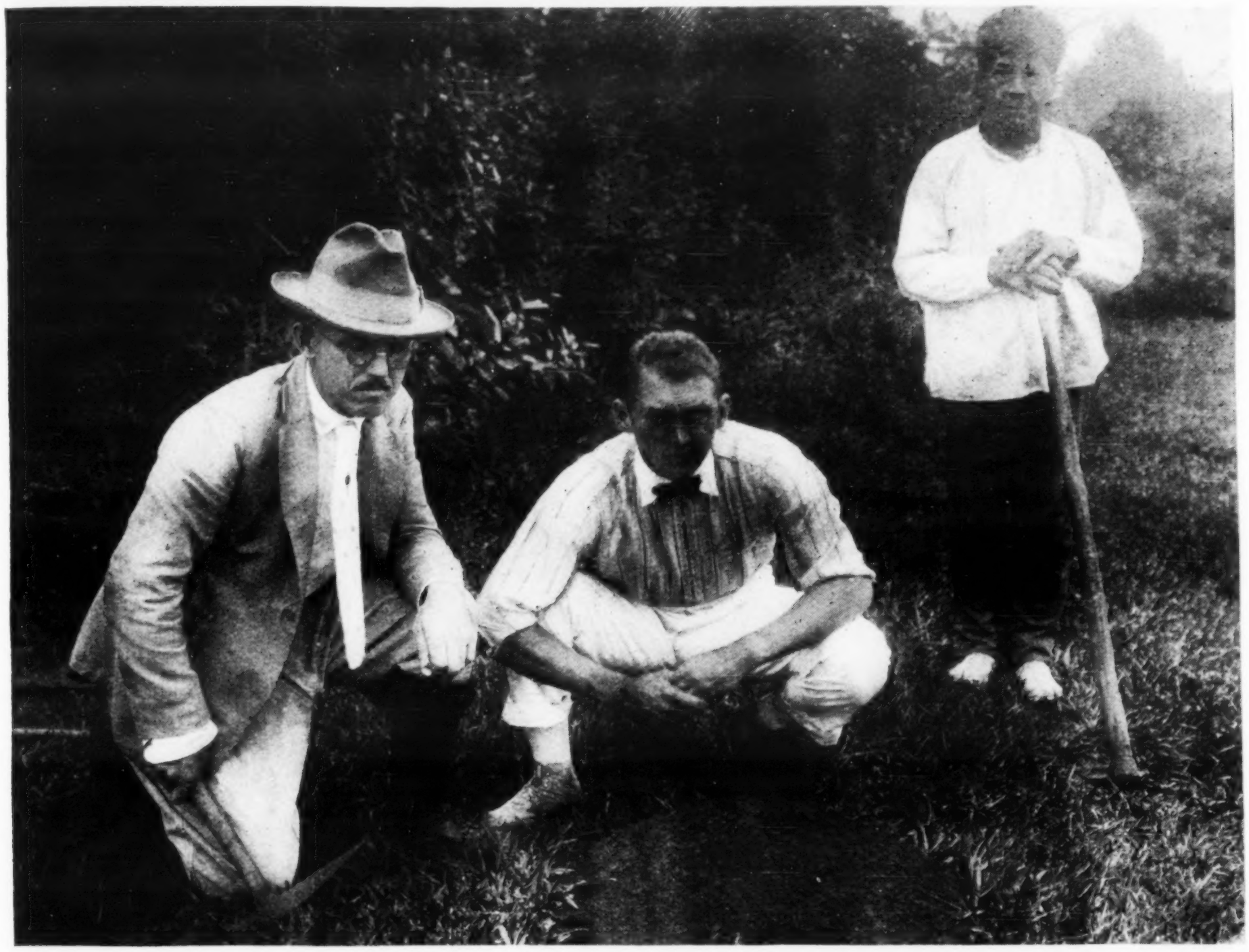
worth while to ask whether the research men may not need from time to time, a radical change in their environment? I can conceive that there might be no more profitable investment than that of a laboratory in the real jungle, when viewed from the standpoint of the output of discovery, and it is this output that the world is interested in. There are many ways of finding out things, but in biology the direct persistent attack of a problem by the study of a limited fragment of the whole field, too often leads to errors which a wide comparison of forms avoids.

Insulin, for example, is a product of the *islands of Langerhans,* which consist of almost microscopic zymogenous tissues in the pancreas of mammals. In the higher fishes, however, the islands are separate, easily seen endocrine glands and already these are being experimented with in a way that the *islands* of mammals do not lend themselves to so well.

I venture to predict that there is scarcely a problem in biology with

BOA CONSTRICTORS AND ANT EATERS ARE FOUND ON THE ISLAND

FIGURE 7. These are two of the jungle animals which will be preserved for study in the Barro Colorado Island Reservation. Dr. Thomas Barbour (left) and Mr. Brooks, of the Agassiz Museum of Comparative Zoology in Cambridge, are shown with a live boa and an ant eater which they have collected for study. The problems of human physiology have reached a stage where the study of the organs of such rare animals can often throw a remarkable light upon obscure points. Who would have supposed that there could be any practical connection between twins and armadillos, or between pituitary glands and the poultry business? But the important relationships of such apparently irrelevant facts cannot be denied.



HUNTING FOR THE ROYAL CHAMBER OF A TERMITE NEST

FIGURE 8. Mr. James Zetek and his assistant, Mr. Molino, hunting for the Queen of a termite colony on the savannah of Panama. The destructiveness of the white ants, or termites, their remarkable fungus gardens and their strange social organization, make them among perhaps the most interesting as well as the most dangerous organisms in the tropics—fascinating to biologists and dreaded by engineers. Through arrangements with the Federal Bureau of Entomology in Washington, Mr. Zetek, who is on the staff of that Bureau as Specialist in Tropical Entomology, will act as the Resident Custodian of the Laboratory, for which position his long acquaintance with the biology of the Canal Zone so eminently fits him.

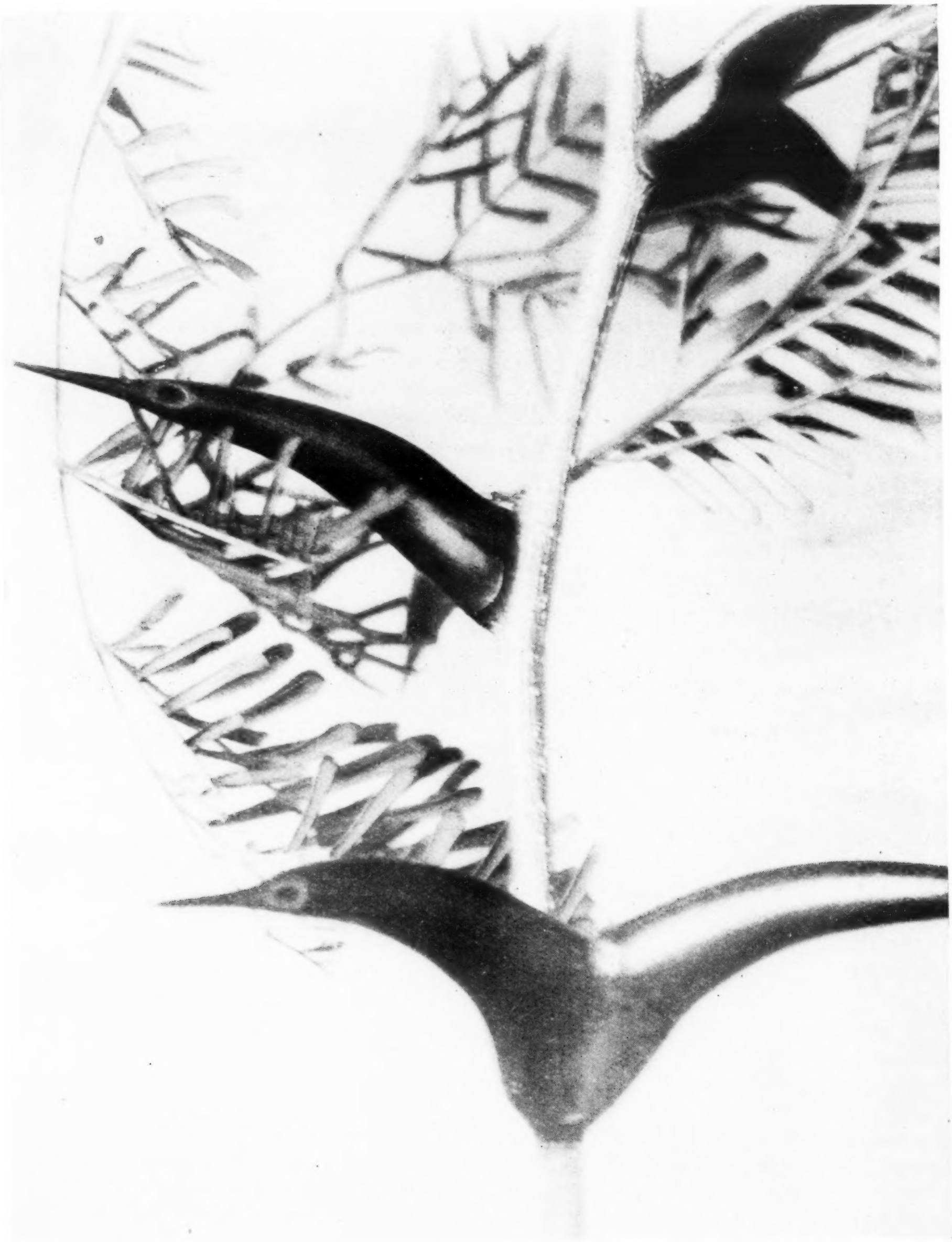
which research men in northern latitudes are at work, that would not have its counterpart in the tropics and it is my impression that the jungle would throw some new light upon it which would be worth while.

The Barro Colorado Island Laboratory plans to offer special facilities to reasearch men who seriously desire to study in the jungles with which the island is covered. At present the laboratory is too small, and the serious character of the researches which will be carried on there this year, is such that it cannot be thrown open to undergraduates nor to any one who is not a mature investigator of recognized ability and standing.

The laboratory is not supported by the government, but is to be maintained, like the Naples Zoological Station, on the Research Table plan. That is, Scientific Institutions and Institutions of Learning, by maintaining their own tables at the laboratory can nominate research men to hold them. Owing to the intimate association into which visitors to the laboratory will be thrown, all those who are nominated for tables will have to come up to certain requirements, much as those proposed for club member-

AT THE WATER'S EDGE AT BARRO COLORADO

FIGURE 9. The abundance of plant and animal life on the shores of Gatun Lake is almost unbelievable, notwithstanding the fact that the shore line was formed only a few years ago, when the Panama Canal was under construction. This great artificial lake opened up miles of nearly impenetrable jungle to exploration by boat, on a scale that is impossible anywhere else in the world.



THE BULL-HORN ACACIA

FIGURE 10. There are many important problems for biology which cluster around this classic example of interdependence of a tiny stinging ant and an acacia with large horn-like thorns, which the ants easily hollow out and use for their dwellings. On the Canal Zone it is certain that many examples of insect and plant interdependence await discovery and study. This photograph shows only the ants' holes in the thorns. Of the ants themselves, future visitors to the laboratory will doubtless bring back important new facts and photographs. The shrub grows well in Florida, but the stinging ant has not been introduced there.

ONE OF THE MUSIC MAKERS OF THE JUNGLE

FIGURE 11. One of the things which makes the tropical jungle a place of mystery are the noises of the night. To anyone accustomed to the stillness of death which falls on the landscape when the sunlight fades in the far north, the din of the night life in the tropics is bewildering. This brilliant green and brown tree toad from the island of Toboga, off Panama, makes an amazingly loud and rather musical note in the daytime as well as at dusk.

ship have to come up to certain standard of personal conduct. Any one who has camped out with other people, knows that the personal equation is the first thing to investigate when it is proposed to add a new member to the camp, for sad experience has taught him how a single undesirable can ruin the peace of a camp.

In several respects this Barro Colorado Island is unique. It is an island by virtue of the fact that the valleys around it were inundated when the waters were let into them to form the great Gatun Lake, through which steamers from every land go and come when they pass through the Panama Canal. It resembles Noah's Ark in one respect; that there gathered in it, as the waters rose, nearly every form of animal life which could make its escape from the rising waters. According to Mr. James Zetek, the Resident Custodian of the Island Laboratory, who has made a careful preliminary survey of its inhabitants, there are two thousand or more species of flowering plants on the island, innumerable species of insects comprising very many which are yet undescribed, reptiles and amphibians of new and strange habits as yet unstudied, as well as several species of Oppossums, Sloths, Ant Eaters, Armadillos, Peccaries, Deer, Tapir, many species of rats and other rodents, among them many rare and curious forms. Agoutis, Squirrels, Racoons, Coatis, the Ocelot, the Jaguar, many species of bat, the night monkey, the white throated Capuchin monkey, the spider monkey and the famous Black Howlers are also found.

The Island Laboratory is only a week's voyage from New York, and it is within easy reach of excellent hotels and restaurants, a commissariat

FLOWERS IN WHICH STAMENS AND NOT PETALS MAKE THE DISPLAY

FIGURE 12. Few experiences are more thrilling to a lover of flowers than when he first walks under the branches of a Malay apple tree (*Eugenia mallaccnsis*) and finds the whole interior of the tree filled with what seems like a scarlet mist and the ground covered with a scarlet carpet made up of myriads of stamens.

second to none, magnificent hospitals with every modern equipment, stores of reagents, glassware and apparatus, and all the living-equipment which a population of ten thousand Americans has been able to devise. It has an untouched forest growth upon it, which rivals in luxuriance any to be found in other parts of the world. The lake which surrounds the island is navigable in small boats and it is indented with hundreds of bays and inlets, making a coastline to explore which must be over a hundred miles in length. There is the mysterious Chagres River which leads away up into the heavily forested mountains near the Atlantic Coast, the Chelibrillo with its great bat caves, the Rio Pescado almost blocked by floating islands composed of vegetation like the Nile *Sud,* and off in the distance, but not too far away to visit during a stay in Panama, is the Volcano of Chiriqui with its prehistoric remains of an Indian civilization and its mountain flora and fauna, which is still little known to science.

The island of Barro Colorado is three and one-half miles long by three and one-half miles broad and its area is about six square miles. Its highest point is 537 feet. With the exception of a few clearings which will be allowed to return to jungle, it is entirely wooded. Passing steamers go within sight of it, and it is only about two miles from the railway station of Freijoles, which is the site of one of the gardens of the Canal Zone for the study of Newly Introduced plants.

In other words, Barro Colorado Island is a choice spot for the location of a laboratory of research in the very midst of actual jungle conditions, and thanks to Governor Jay J. Morrow's broad policy and his appreciation of scientific work, it has become such a site.

Since I am convinced that this represents an initial step towards the actual study by our best research men of the great biological problems of the tropics, it may not be out of place to sketch here the personalities and events which have brought the Island Laboratory into existence.

For many years there has been on the Canal Zone a man thoroughly interested in its plants and the insects which prey upon them, Mr. James Zetek, Specialist in Tropical Insects of the Bureau of Entomology of the Federal Department of Agriculture. He has watched with growing concern the destruction of the forests and has talked with the visiting scientists who have passed through the Canal. In the spring of 1923 Mr. Zetek conferred regarding his dream of a Natural Park, with Dr. William Morton Wheeler, Dean of Bussey Institution, Dr. Richard P. Strong, Director of the School of Tropical Medicine of Harvard, and Dr. C. V. Piper, Agrostologist of the Department of Agriculture, all of whom happened to be studying on the Zone at the time. The enthusiastic support of the plan and the hearty cooperation which was given it by Colonel William Erwin, Land Inspector, and Mr. N. A. Becker, the Land Agent of the Panama Canal, were most important factors in bringing to pass the event which in years to come should prove of great moment to the scientific workers of America—the establishment of a research laboratory for naturalists on the Isthmus of Panama. In setting aside the island as a Natural Park Governor Morrow issued the following brief circular:

Balboa Heights, C. Z.
April 17, 1923.

TO ALL CONCERNED:

Barro Colorado Island in the Gatun Lake area of the Canal Zone is hereby reserved for use as a Natural Park, subject to later arrangements for its development. This island is also known as West Island.

Hunting game of all kinds is prohibited on the island, except for strictly scientific purposes, for which a special permit shall be issued by the Governor or by his direction.

JAY J. MORROW, *Governor.*

Naturally it is to be hoped that this little jungle laboratory, which the Governor has permitted on the island, will be only one part of the vast equipment for scientific research which is destined to be located on this great Isthmus which joins two continents and is threaded by the traffic of the world.

Contributing to this equipment, there are already many advantages which the Zone has to offer to the environment of any research worker who goes there. There are the popular and technical libraries, the large laboratories connected with the hospitals and those of the Board of Health, the churches, theaters, athletic organizations and excellent social centers of the Y. M. C. A. The Panama Railroad puts one in touch most conveniently with a strip of territory ten miles wide and forty miles long—the Zone. Automobile roads lead to places where the railroad does not, and launches are available for trips to the remarkable islands of Taboga and for trips up and down the Atlantic and Pacific Coasts where comparisons can be made between the faunas and marine floras of the tropical forest, open savannas, fresh and salt-water areas bordering these two great oceans.

Restaurants remarkably neat and furnishing good, wholesome food at moderate prices are in operation on the Zone, and it is possible to live well at these for forty to fifty dollars a month, whereas the commissaries operated by the Canal Government supply almost everything needed for housekeeping at cost. In Panama itself are many good stores.

The Republic of Panama welcomes with its usual cordiality any scientific investigator who may wish to visit places in its vast interior forest regions or explore its mountains or navigate its long swift tropical streams, and, with the increase which is coming in its road building program, will be able to offer excellent opportunities for collectors who wish to make wide surveys of its tropical flora and fauna.

At the present time there are three other projects to establish institutions for scientific research in the Canal Zone. President Porras of Panama has under consideration the founding of a marine biological station, the program of the Gorgas Memorial Institute includes a laboratory for the study of medicine and Public Health in the tropics, and Governor Morrow is interested in a comprehensive undertaking to establish a great garden, or several gardens where useful and ornamental plants may be brought together and studied. There appears to be no reason why all of these should not gain headway and grow until the Canal Zone takes the place it ought to take in the scientific exploration of the Tropical Zone, attracting to it the vast investigative and inventive intelligence of our American Scientific Institutions.

This laboratory is a start toward such an end, and thanks to the energy and generosity of several interested persons in the North and the hearty cooperation of Governor Morrow, Lieutenant Governor Walker, Mr. Morris, Colonel Fisher and others, Barro Colorado Island Laboratory will open this summer. Its attractions are quite as great in the summer as in the winter. During August the temperature ranges from 71° at night to 90° in the day time, as welcome a relief from the 105°F. of our Washington summers as are its December extremes (69° to 89°F.) from our below zero winter weather.

This Laboratory deserves to receive the support of the Scientific Institutions of America, and if it does, will be the starting point for greater developments on the Canal Zone, where already the Government has made life safe and created living conditions which cannot be equalled anywhere else in the tropics.

Mr. James Zetek, who has been authorized to act as resident Custodian of the Laboratory has prepared a detailed account of Barro Colorado Island and the new laboratory, for

Dr. Shelford's Naturalists' Guide for 1924. Any research men desiring to visit Panama are advised to consult this account. Since the understanding with Governor Morrow is that the Executive Committee of the Institute for Research in Tropical America shall pass upon the credentials of all who desire admission to the laboratory, applicants should submit their qualifications to the Chairman of the Executive Committee of the Institute, in care of the National Research Council, Washington, D. C.*

As representative of the American Genetic Association, I have taken a keen interest in the establishment of this laboratory and I believe its use by research men in the field of Genetics will give new encouragement to them and stimulate their imaginations in a very lasting and valuable way, leading to new discoveries of the greatest importance.

*A visiting scientist should notify, if possible, by letter beforehand, the Resident Custodian, Mr. James Zetek, Box 245, Ancon, Canal Zone, the time of arrival of his boat, so that the custodian can have the railroad passes ready for him on his arrival. He should telephone, on arrival at Cristobal, to the Ancon Hospital and get into communication with the custodian who will inform him of details regarding his luggage, etc. Then taking the train to Panama City, he should put up at the Tivoli Hotel and call upon the custodian, whose office is in the Ancon Hospital and who will assist him to arrange to get to the laboratory. No passport is necessary for one visiting the Canal Zone or the Republic of Panama.

Eugenics for the Layman

THE NEW DECALOGUE OF SCIENCE, by ALBERT EDWARD WIGGAM. Pp. 314, price $2.50. Indianapolis, the Bobbs-Merrill Co., 1923.

Mr. Wiggam gives a simple and interesting exposition of the ideals of eugenics, and then goes farther, to assert the necessity for adopting a scientific point of view in all social questions. An enumeration of his "ten commandments of science" will suggest the contents of his book: (1) the duty of eugenics, (2) the duty of scientific research, (3) the duty of the socialization of science, (4) the duty of measuring men, (5) the duty of humanizing industry, (6) the duty of preferential reproduction, (7) the duty of trusting intelligence, (8) the duty of art, (9) the duty of internationalism, (10) the duty of philosophical reconstruction. The warm reception which the volume has received from the public is the best evidence that people want to learn about these subjects, and that they understand and enjoy what Mr. Wiggam has to say about them. The book can be recommended to anyone who wants a clear and vivid account of the necessity for infusing more applied biology into the conduct of civilization.

P. P.

BETTERING THE BIRTH RATES

ERNEST DODGE,
Civil Service Commission, Washington, D. C.

EUGENICS as a science is still in its infancy. But conditions have rapidly developed in our age which make it imperative that eugenics shall develop into a mature and popularly understood science before it is too late. Otherwise irreparable losses threaten the human race.

May we not sit down together around the hearthstone of our minds and give a little serious thought to what the world may be in future centuries, when our children's remotest grandchildren shall be enacting their joys and sorrows on its stage? With only one of the three main divisions of eugenics are we concerned at this writing. We shall not discuss the hopeful efforts for the eradication of those diseases which taint the offspring, which after all is only a very secondary subject. Neither shall we refer to the Mendelian laws of heredity, showing how undesirable tendencies inherited from our forebears may largely be prevented from cropping out in offspring by suitable selection of a mate. Our thought shall be of that phase of the eugenic problem which regards mankind as part of the general process of evolution, whose laws as shown in the past we must study to determine the proper goal of future progress.

To the general principles of evolution, then, let us turn our thought for a few moments. Darwin's great service to science was not in fully explaining the processes by which evolution has come about (for that he did not do), but in convincing a hitherto incredulous world of the fact that evolution is the true story of creation; that men and animals and plants alike are differentiated descendants from an original very simple stock of life that was measurably the same for all. He convinced the world of this great truth through his plausible explanation of the origin of species through what he styled "natural selection," or as otherwise termed, "the survival of the fittest." In announcing this principle Darwin was a pioneer, and was no more able than any other pioneer of science to discern the whole truth from the very start. His principle of the survival of the fittest may indeed be expanded and liberalized to cover the whole sublime truth that those types finally tend to prevail which are most in harmony with the basic laws of the universe; but in the hands of some earlier and narrower teachers too often "survival of the fittest" was interpreted to mean nothing deeper than the survival of the "fightingest." No wonder theologians and moral teachers stood aghast. And no wonder the nation which accepted that dangerous partial view of the law of life's "kultur" plunged itself and well nigh the world into retrogression and failure.

The genuine men of science at present accept the view that nature's decision as to which families of living creatures shall survive and which shall fall by the way depends upon factors very complex and yet imperfectly understood. Beyond doubt the strong, the swift, the hardy, the courageous, the prudent, the camouflaged, have a certain advantage in the quest for perpetuity over the weak, the slow, the delicate, the cowardly, the rash, and the conspicuous, yet many other factors and laws are at work in the great drama of creation, which we can arrive at only little by little and by patient study. Besides "natural selection," Darwin himself in later years wrote very convincingly about what he termed "sexual selection," and subsequent writers have spoken of still other factors in the problem. Especially did

Henry Drummond render a service by emphasizing the influence of altruism in the evolutionary process, showing that along with the struggle for the life of self there has been an equally important "struggle for the life of others." He might well have summed up his contribution to the problem by coining such a phrase as "the survival of the best loved."

To put in other words the somewhat difficult thought we are feeling after, the course of evolution is not entirely the adaptation of the creature to its *external environment;* in part it is the adaptation of the creature to its *internal environment*—to an invisible background of patterns and purposes which are a part of its animal inheritance. Every bird and beast and tree has grown from primitive ancestral forms to be what it is today not merely through a vague struggle for some form of continued life, but through a struggle to live *its own* kind of life in its own way.

We are now ready to approach the question as to the kind of future development toward which it is proper for human society to aspire, because of patterns already outlined in the basic needs of our nature. What sort of a world may we hope that this may be five hundred, five thousand, or fifty thousand years from now? That is a sane and conservative question, for the periods named are short in comparison with the whole past history of the human family. The answer is that the development must proceed between now and then in harmony with the great principles of evolution in general, and in particular the higher laws to which we have been referring. Let us apply these, each in its turn.

We began by recognizing both egoism and altruism as factors in evolution. Now altruism, or regard for the life of others, referred in its most primitive appearance to the care of a parent for eggs or living offspring. Following this was the stage where affection arose between mate and mate. Next, in certain specially ethical species, there developed a flock loyalty, seen in some birds and same herds of mammals, notably wild pigs and certain monkeys. In most human beings, when not inflamed by the baser passions, there is some degree of the still higher stage where there is care for any member of our own species, a willingness to risk self in rescuing even a stranger from imminent peril. And rounding out this cloak of nobility like a fringe are such beautiful minor manifestations even outside one's own species as the love of a man for his dog, with kindness for the humbler world in general.

So we come to see that altruism, after all, is not so much the opposite of egoism as its ennoblement through expansion to its logical limits. By sympathy and appreciation we come to include within the limits of ourselves what at first seemed outside of ourselves and even hostile to us. So we recognize at last that we personally, no less than nature in the large, fundamentally love all the many and various manifestations of life—even the harsher and coarser and uglier, so long as they are *"kept in their place,"*—since without them as a part of the environment our own narrower lives cannot be made perfect. It is only under the superior urge of danger to our own existence that we fight against any other life. Curb the danger, and our former foes become objects first of toleration, then of curious interest, then of appreciation, and finally of love.

Now I think we are ready for one more and final step in our speculation—all of which, be it remembered, is in preparation for a rational program of eugenics. May it not be a prerogative of man that he shall not merely illustrate evolution but improve upon it, building upon the old foundation but adding higher stories of his own? For man's rational self-control makes possible a course of action by which to those forms which are interesting, indeed, yet deadly or primitive, he may assign their "due place" by consigning

them not to the *past*, but to a position of *extreme minority*.

As regards ability, our population is made up of geniuses, talented people, ordinary people, stupid people, and fools. Surely we all hope that five hundred years from now the percentage of highly gifted people will be greater than now—such is the path of progress—and the ratio of stupid people and fools much diminished. But is it necessary to hope that the breed of stupid people and fools shall become wholly unknown? Some of us will vote in the negative. If defective and stupid people today find life worth living, a few stupid posterity of these same people may find life worth living a thousand years from now; and then as now they may serve a function in the complex body of humanity. In similar terms we may speak of the weak and the strong, the plain-looking and the beautiful, the erratic and the perfectly balanced, the backward or imitative races and the races gifted with leadership. It is harder to say this of the immorally elemental as against the morally disciplined, yet perhaps in time our largeness of heart and broadening viewpoint may even in this bring us into likeness with the divine mystery of nature which sendeth rain upon the just and the unjust, and giveth sweet sleep to the guttersnipe and the saint.

One can easily see what path the race must follow if this picture of an improved yet interestingly varied future is to become an actuality. *All* normal and interesting types, even the rougher and more primitive, must be allowed to propagate themselves, but the more rapid propagation, with the more numerous offspring, must be steadily practiced by the types which are interesting on the higher and nobler planes—the beautiful more than the ugly, the gentle more than the turbulent, the disciplined more than the rudely elemental, the vigorous more than the weak, the talented more than the stupid. We have said it is man's prerogative not only to illustrate evolution but to improve upon its earlier methods. If we may dare to use the word "purpose" in connection with results achieved through the evolutionary past, then we shall say that when the purpose was to cleanse the American continent of its terrible fauna of tyrannosaurs and triceratops in order to make room for deer and bison and black bears, with their higher intelligence and higher capacity for affection, those many races of dinosaurs were swept into extinction. The result could hardly have been reached with any halfway measures, for those great creatures, guided only by natural passion, tended to breed and multiply without limit, and even a small remnant of tyrannosaurs might have staged a "come-back" and again overspread the continent, to the ruin of the new and higher types. Man alone has conceived and started to execute the idea of regulating the rate of propagation of different living types to suit the present needs of the dominant and higher interests of society. If, for example, the country needs five million horses there will be five million horses on hand to meet the need, but there is no danger of there accidentally being fifty million.

Man has progressed a long way in applying the sound supply-and-demand principle to the animals under his control in domestication, but he has not even started to apply it to his own species. Up until now this backwardness has probably been fortunate, for in the past states of human ignorance and of the tyranny of the strong over the lowly any eugenic experiments of man upon man would have ended in disaster to the better interests of the race. Those of us who have read that fantastic and fearful novel, *The Messiah of the Cylinder,* shuddered, I am sure, at the picture of how in the future such experiments might end in tyranny, cold intellect, superficial and sensual beauty, and a narrow-minded insistence upon uniformity in non-essentials. And the cruelest thing of all in the picture was the systematic denial of the common blessings of wedlock and parenthood to the multitudes

who by arbitrary and technical standards were classed as "defectives."

Yet in spite of the risk that mankind may bungle its job when it undertakes it, we are compelled to recognize that the social regulation of fecundity, with a view to stocking the future with the right grade of human beings, is a thing which cannot much longer be postponed lest it be forever too late. Present-day conditions in the most enlightened nations have brought on a crisis. For in our generation the finest blood of the most gifted peoples, instead of gaining ground, as it must if progress is to continue, is losing ground at an alarming rate.

In our mind's eye let us have standing before us all citizens of the United States between the fruitful ages of 25 and 45. Let us go through them and classify them as to their native intelligence, their native capacity for culture, their general position as high or low in the scale of human endowments. Let us pick out the one-tenth who are noblest, most gifted, most full of promise for making the future world a society filled with persons of finer intelligence and culture than is the world of today. In our mind's eye let us set this best one-tenth apart from the less gifted nine-tenths and let us ask them what the choice blood in their veins is going to be doing in the world of a thousand years hence. Let us suppose, for convenience, that this best flower of all past evolution consists, so far as our country is concerned, of a million men and a million women, two million altogether. If the present rate of "increase" continues, how many children of these two million are there going to be in the next generation? Probably less than fourteen hundred thousand, owing to the numbers who will not marry and the growing popularity, among the married, of the childless home or the home with only one child. But let us give hope the benefit of the doubt and say fourteen hundred thousand, which implies an average for every adult man and woman of one and four-tenths offspring, in addition to any who may die before maturity.

At the same rate, with the same suicidal tendencies unchecked, how many grandchildren will there finally be from the present two million of America's best young blood? Only one million. How many grandchildren's grandchildren a hundred and fifty years hence? Only half a million. How many posterity four hundred years hence, assuming for clarity the continuance in like degree of the present tendency on the part of the best to dwindle out through lack of offspring? Less than seventy thousand! And if we continued to the limit of a thousand years with this *reductio ad desperandum*, we should have the present two million best of America's maturing generation represented in that later world by a posterity of less than five hundred souls!

From this point on we may be treading on dangerous ground, but we must bring out clearly that necessary principle for the future organization of society to which all the foregoing has been leading us up. What the kingdom of heaven upon earth implies we have already tried to discover, through studying the way the forces of the universe have worked in creation hitherto. And we found it to include such a conscious control by mankind of its own destinies that the gentler, stronger and more finely gifted elements of society shall be ever on the increase, yet without trampling on the individual right to happiness of any member of the race, however primitive, lowly or perverted, and without robbing the world of that sweet and necessary variety and multiplicity of endowments which accords with the Divine purpose in creating both man and all creeping things and in pronouncing them all as very good.

Partly, of course, the improvement which the world desires will come through improved education and improved sanitary methods, along with improved social standards in certain familiar matters of conduct. But that is not all, for it is eternally true that

"blood will tell." Let us picture the society of late future centuries as organized along the lines which these thoughts suggest. Eugenics shall have ceased to be an affair for academic discussion. By law and social custom, backed by universal public opinion, it shall have taken its place as arbiter of the race's future.

Suppose the wisdom of society as a whole shall say to any young married couple: "You have been measured and tested, not merely on the basis of your individual performances but by the more important standard of the performances of the ancestors whose blood is flowing in your veins. You are found to be of that fine minority who are highest in health and mental vigor, in sweet reasonableness of disposition and general promise along noble lines. For the blessing of the world the next generation must contain a larger percentage with blood such as yours is than the present generation contains. Where two parents such as you are shall unite to form a home, there must emerge *more than two* children to form an increased part of the coming world. This is your assigned and positive duty to society, your soldierhood to the great human commonwealth. You will not even desire to be slackers in this warfare against the insidious forces which would thwart the divine purposes of evolution."

Then let us suppose that the wisdom of society as a whole shall say to another young man and woman: "You also have been measured and tested, but you are found to be of that scantily gifted group who stand lowest in mentality, or in physical constitution, or in disposition to control passion and to give service to others and in general to forward the noblest interests of the race. For the blessing of the world the next generation must contain a smaller percentage with blood such as yours than the present generation contains. Wherever two people such as you are shall unite to form a home there must never emerge more than two children to demand room in the coming generation. If only one child comes into the world to bless your union it is just as well; no hint of opprobrium shall rest upon you for modestly accepting such a smaller share in the continuance of society. If your inclination leads you to refrain from marriage altogether, or in marriage to forego the blessing of offspring, you will not be called slackers. Nevertheless, remember, society recognizes you as human beings with rights to happiness no less than your superiors. Even though you be a cripple or a weakling, an unbalanced neurotic or a back alley incompetent, society does not propose to extinguish you by arbitrary force. The world of which you are a part recognizes that perhaps you are the very ones to whom a mate and a little home and a smile from the cradle will mean everything, your one ewe lamb of comfort in an otherwise cramped or broken life. No opprobrium rests upon you if you choose, despite your inferiority, to reach forth and grasp at these common human blessings. Society's only restriction upon you is that you shall not overflow and swamp the future with increasing numbers of persons below the standard of body, mind or heart."

A method like this for gradually improving the average grade of the human race will be slow in its action, showing but moderate results between one generation and the next. But unlike some laws suggested by the agitators of our day for refusing the right of marriage entirely to certain defective groups, it is worthy of our humanity because it is humane. And there are plenty of centuries coming, if only the trend be in the right direction. For the law of this progressive improvement in the general average is like compound interest, which amounts to but little in two or three years but piles up to amazing figures as time elapses.

Such a method, intelligently followed for five or ten centuries, would practically rid the race of such deficiencies of mind and body as can be ascribed to defects in the ancestry, and would

multiply the numbers of talented, wholesome and righteously happy individuals. And these ends it would accomplish without encouraging selfishness or cruelty on the part of the gifted majority. These ends it would accomplish without denying to the afflicted the right to all the happiness they can reasonably appropriate.

And remember also, these ends it would accomplish without imposing upon mankind an uninteresting uniformity. There would still be tall men and short men. There would still be white men and black men and yellow men. There would still be the beauty of red-headed blonds and of dark-eyed brunettes. There would still be musical geniuses without a bit of business sense, and fine business men who didn't play chess, and chess prodigies who didn't care for painting. The efforts of the race will not be to lessen the number of distinct types, whose presence alone it is that makes life interesting, but to develop fine specimens of each and every type, while making rare those imperfections and afflictions which even the victims thereof recognize as evils and would fain escape from.

We shall not protract this discussion to inquire who, in future centuries, will be so wise that they may be entrusted with dividing the youth of each generation into four or five or six classes on the basis of their hereditary endowments, in order that society may demand that they regulate the reproductive function accordingly. Nor need we be troubled over the question as to how, in a matter complicated by individual passions, society will find a way for enforcing its decrees. These difficulties are less formidable than they appear. For compulsory enforcement of such decrees there are already devices known to science. But public sentiment is a force all powerful when unanimous and confirmed by age, as witness the elimination, by public sentiment, of sexual liberties between close relatives. And there will not be, nor indeed should be, any attempt to enforce by law the ideals herein set forth until individual sentiment has largely been educated to demand their observance.

For the youth of our own generation these momentous issues are matters of conscience only. But conscience is now sadly asleep with both the defective and the gifted. The appeal cannot be made too strong or be urged by too many voices.

The young married couple who know themselves to be clearly in the class of weaklings and back alley incompetents should have it drilled into them on every side that they are trespassing on ground where they have no right if they launch into the next generation more than one or two children at the most. And as for the young married couple of culture and ability, either with or without wealth, they should be awakened to see that socially speaking the war between racial progress and racial decline is unceasing from generation to generation. They must come to recognize that they are drafted for world service by a draft board higher than any established by man, and that they are slackers in the world's work if they purposely evade the responsibilities of parenthood—plural parenthood, such as is necessary to maintain and expand the world's population of the best bred.

HERITABLE CHARACTERS OF MAIZE

XVII—Intensified Red and Purple Aleurone Color

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IN THE spring of 1920, Professor R. A. Emerson turned over to the writer a number of ears of corn which were to furnish the foundation material for a study of certain aleurone characters. Among these were some ears which were segregating for light red kernels and kernels of a very dark color, almost black. A count of the seeds of these two kinds showed that there were approximately three of the light to one of the dark. One or two other ears showed a similar type of behavior with respect to the purple aleurone color, that is, there were light purple kernels and black kernels on the same ear, with the former occurring more frequently than the latter. From this material there were isolated homozygous strains of light reds, light purples, and their corresponding blacks. Studies were then made of the genetic nature of these types of aleurone colors.

East and Hayes[2] † and East[1] came to the conclusion that two dominant factors, *C* and *R*, are necessary for color development in the aleurone layer of a kernel of corn together with *i*, the recessive allelomorph of the color inhibiting factor *I*. Emerson[3] showed that a third dominant factor, *A*, must also be present before color will develop. The fundamental color series, therefore, is *A*, *C*, *R*, and *i*. When to this series there is added a dominant factor, *Pr*, purple color is developed.[2 3] A recessive *pr* with *A C R i* causes the development of red color. In addition to these five factor pairs, a number of other aleurone factors have been discovered and studied. Many of the latter affect the distribution of aleurone pigment in various ways, to give mottling, blotching, and stippling effects.

A study of the black kernels mentioned above has led to the conclusion that both kinds are caused by a recessive factor, to be designated by *in*, which operates in the one case in conjunction with *A C R pr* to produce an intensified red, and in the other, with *A C R Pr* to produce an intensified purple. These two types of blackish kernels are genetically distinct, therefore, since they are different with respect to the *Pr pr* factor pair. For this reason, the term "recessive black" has seemed inexact, and the factor has been named from its most constant effect which is one of intensification of color.

Intensified Red

The intensified red kernels, when well developed and well matured, are generally of a dull blackish color, sometimes with a brassy appearance. Here and there parts of kernels may show traces of very dark red, and in the case of poorly matured seeds the whole kernel is deep red rather than black. Tests have shown, however, that these dark red kernels will give rise to plants bearing wholly blackish seed, provided the season is long enough for the color to develop fully. Material which is segregating for this factor cannot be classified accurately unless it has been well matured. Emerson[3] (page 250) says: "It is the writer's experience that the development of aleurone color is usually influenced noticeably by the degree of maturity of the seeds, and that its appearance is affected by the composition and color of the underlying

*Paper No. 127, Department of Plant Breeding, Cornell University, Ithaca, New York.
†For numbered reference see Literature Cited at end of article.

endosperm. It is true that aleurone color begins development in very immature seeds, but its intensity is greatly weakened by immaturity." Another difficulty in classification arises from the fact that the *In* factor is not completely dominant over *in*, and that when the *in* factor is in the two *X* condition in the aleurone, that is, *In in in*, the kernel may be dark enough to approach the lighter grades of *in in in* aleurone and be confused with them. This last difficulty is less apparent, however, when all of the corn has had a long growing season and is well matured.

Intensified Purple

Purple seeds of the ordinary type are usually a dull slate purple in color, with here and there traces of dark violet. The intensified form of this color is a very deep black, much more truly black than is the intensified red, and quite distinct from the true purple when homozygous ears of the two sorts are compared. Here again, however, the separation of purples and intensified purples is rendered difficult, partly by the presence of incompletely matured, intense purples, and also by reason of the fact that the range in depth of color from the light to the intense purple is not a wide one. In the case of the purple color, the one *X* and the two *X* conditions of *in* are scarcely to be told apart.

In all of these studies of the recessive intensifying factor, the material was examined and classified only once. Doubtful kernels were carefully compared with fixed standards as to shade of color, and no attempts were made to reclassify any lots of seed. It was felt that this method resulted in the most accurate and unbiased classifications possible.

Genetical Tests of the Intensified Red

Crosses of *intense red* × *light red* gave, in all cases, F_1 seed which were light red in color and yet appreciably darker than the light red parent. The F_1 of the cross *intense red* ♀ × *light red* ♂, was darker than that of the cross *light red* ♀ × *intense red* ♂. This was presumably due to the difference in color resulting from the one *X* and two *X* conditions of the aleurone layer with respect to the *in* constitution. The F_2 results were the same in both crosses (Figure 13). These are given in Table I.

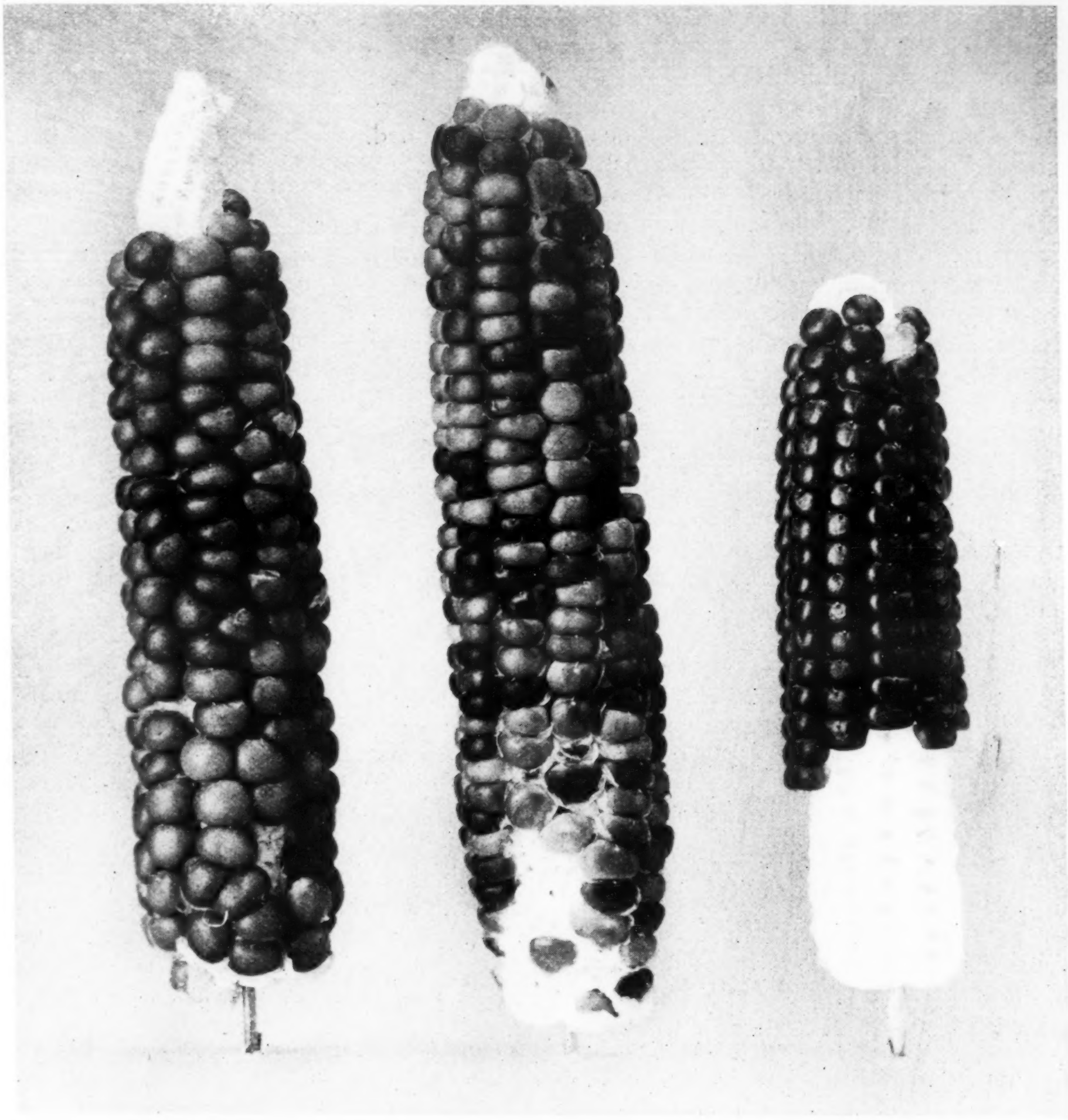
The somewhat wide deviations of observed from calculated results in the case of pedigrees 82 and 85, Table I, may be due in part to the fact that shrunken endosperm was involved in these crosses and it was difficult to make exact classification of the shrunken seed with respect to color. On the other hand, it must be admitted that the classifications in the case of pedigrees 17a, 17b, and 22, where the agreement is very good, may not be absolutely accurate for every individual. A breeding test might show that some have been classified as homozygous intense red when they were in reality hybrid, and also that some were classed as hybrid kernels, when they were poorly matured blacks. In 1921, a test was made of a number of the doubtful color types in one of these F_2's. The results of this test showed that on the whole, the F_2 frequencies were practically correct, as the slight changes which had to be made in both classes did not alter the size of those groups appreciably. The results given in Table I seem clearly to indicate a monohybrid relationship between the light red and the intensified red.

Pedigree 17a of Table I was segregating for white aleurone as well as for the intensifying factor. The F_1 from which this family came was of the genetic constitution *A A C c R R pr pr In in*. Theoretically the F_2 should consist of the following types, if *in* and *c* are inherited independently of each other:

9 *A C R pr In*—light red.
3 *A C R pr in*—dark red.
3 *A c R pr In*
1 *A c R pr in* —white.

The totals of counts on eleven F_2 ears were:

	Lt. Red.	Int. Red.	White	n
Observed	2552	857	1138	4547.0
Calculated	2557.8	852.6	1136.8	4547.2



LIGHT RED
A C R pr In

SEGREGATION IN SECOND GENERATION

INTENSIFIED RED
A C R pr in

INHERITANCE OF LIGHT, RED AND INTENSIFIED RED IN MAIZE

FIGURE 13. The development of light red aleurone color in maize is dependent on four distinct mendelian factors. The intensified red is produced by a fifth recessive factor. In the first hybrid generation the grains are slightly darker than pure light red grains and in the second generation, segregation occurs in a 3:1 ratio. Photographed with ray filter and pan-chromatic plate.

These data seem to point to an independent assortment of the *In in* pair and the *C c* pair of factors, since the observed results agree very closely with calculations made on such a basis.

Some of the whites of family 17a were tested further in F_3. According to the F_2 behavior of this family, it would seem that there should be three kinds of white kernels in that generation, all having *A A R R pr pr*. These might be represented as follows:

1 *c c In In*, 2 *c c In in*, and 1 *c c in in*.

It was desired to isolate, for another purpose, a *c c* strain of corn (*c*-tester) having *in in*. This involved a double pollination of the above named whites, one to get selfed seed of the desired strain and the other to distinguish the white which carried *in in*, from the other two sorts. A number of white seed from pedigree 17a were planted and each resulting plant was pollinated with a mixture of two kinds of pollen, its own and that of an intensified red strain, i. e., carrying *C C in in*. Seeds resulting from fertilization by the plant's own pollen would all be white. Those from the other pollination would all be colored and would furnish the test of *in* in the unknown sort. The theoretical results of such a test are shown in the first three columns of Table II. In the fourth column are given the actual results of a test made in 1921, and column five shows the calculated frequencies.

Linkage Studies With "In"

Intensified red strains have been crossed with a number of known genetical types with a view to finding some factor with which *in* is linked. Most of these tests have not been completed. It happened that many of the other types of corn which were used brought in dominant *Pr* and this made the classification of intensified kernels very difficult and quite inexact. It has been necessary, therefore, to isolate combinations homozygous both for the test factors and for recessive *pr* before any further study of relationships could be made. Data available at the present time point to no linkage of *in* with either *C* or *Sh*. Further data must be obtained before any conclusions can be drawn regarding possible linkages with the other factors.

Tests of the Intensified Purple

Light purple (Pr In) × intense purple (Pr in).

Owing to the intergradation of purple colors and the relatively slight difference in shade of color between the purple and its intensified form, exact classifications of light purples and intensified purples were impossible in this cross. However, the very darkest kernels were selected from the F_2 ears and homozygous intense purple strains were established.

This extracted intense purple was crossed with a light red and the resulting F_1 was a light purple. In the F_2 of this cross, light purples, light reds, and blacks appeared. Satisfactory counts could not be made, but the theoretical relationship of 9:3:4 seemed to hold. The F_1 was *A A C C R R Pr pr In in*.

In order to ascertain whether or not the intensification of the red and of the purple was due to the same genetic factor, crosses were made between the two intensified color types. According to genetical theory, if the intensifying factors had not been allelomorphic to each other, these crosses should have given light purple F_1 seed. The F_1 seed were all an intense black, however. Four ears of F_2 seed (pedigree 368) also failed to show any light colors, although there were differences in the intensity of color of many of the kernels. The behavior of both F_1 and F_2 in this cross was taken as good evidence that the same *in* factor was operating in the case of intensified red and intensified purple. By theory, this F_1 was *A A C C R R Pr pr in in*, and the F_2 should have been segregating for intensified purples (*Pr in*) and intensified reds (*pr in*) in the ratio of 3:1. The segregation of the *Pr pr* pair was actually obscured, however, by the effect of the *in* factor. A simple breeding test showed that the F_2 blacks of pedigree 368 consisted of 1 *Pr Pr in in*, 2 *Pr pr in in*, and 1 *pr pr in in*. A number of kernels were taken at random from this family and planted under the F_3 pedigree number 670. The plants which grew from these kernels were crossed with pollen of pedigree 671, which was *A C R pr In*, a light red. The following kinds of ears were obtained:

3 ears having only light purple seed.
4 ears having light purple and light red seed in approximately equal numbers.
3 ears having only light red seed.

It will be seen, therefore, that pedigree 368 was in reality segregating for the *Pr pr* pair.

Summary

The facts reported above seem to justify the conclusion that certain blackish colors of the aleurone layer are produced by the combined action of a recessive factor, *in*, and the fundamental aleurone series *A C R i*, together with either *Pr* or *pr*. The normal allelomorph (*In*) of this factor results in light shades of color. Two kinds of these blacks are recognized genetically, one a modification of light red, and the other of light purple. They differ in the *Pr pr* factors and apparently the intensity of their color is due to the same gene, *in*.

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Table I—*F₂ of Intense Red × Light Red.*

Pedigree	No. of ears	Observed number: Light red	Observed number: Intensified red	Calculated number: Light red	Calculated number: Intensified red	n	D	P. E.	D/P.E.
17a	11	2552	857	2556.75	852.25	3409	4.75	17.05	.28
17b	9	2786	949	2801.25	933.75	3735	15.25	17.85	.85
22	16	3574	1179	3564.75	1188.25	4753	9.25	20.13	.46
82	12	3264	1004	3201.0	1067.0	4268	63.00	19.08	3.30
85*	5	1238	380	1213.5	404.5	1618	24.50	11.75	2.09
		13414	4369	13337.25	4445.75	17783	76.25	38.95	1.96

*Pedigree 85 is reciprocal of Ped. 82.

Table II—*F₃ Tests of F₂ Whites.*

Genotype of F_2 white	X own pollen	X pollen of A C R pr in	Number of ears: Observed	Number of ears: Calculated
c c In In	all white	all colored seeds light red	15	10
c c In in	" "	1/2 of colored seeds light red, 1/2 dark red	17	20
c c in in	" " *	all colored seeds dark red	7	10
			39	40

*These Whites saved for other tests.

A FLOCK OF GROMET SHEEP

FIGURE 14. Showing the variation in distribution and extent of the gromet markings.

THE "GROMET" PATTERN IN SHEEP

Another Mendelian Character in Livestock

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THE GROMET PATTERN

FIGURE 15. Black marks over the eyes, black ears with grey margins, and occasionally, dark stripes on the neck and breast, as shown here, characterize the gromet sheep. These markings are not infrequent in herds of sheep in certain parts of Norway. The character is inherited in mendelian fashion and is recessive to ordinary white.

IN the Western part of Norway one frequently sees sheep with a light grey, mottled head, with a black design over the eyes, on the bridge of the nose, and on the upper and under lip. It often happens that the black color is also spread over the cheeks. The ears are black with grey margins. Except for a grey stripe on the front of the foreleg and on the side of the shin, the legs are black. Occasionally there is also a black stripe on the neck and breast. The limits of variation in the type are well shown in the accompanying illustration. This color marking is called *Gromet* in Rogaland Norway.

In my travels in Rogaland I saw in several herds, lambs from white parents that had this marking. One of the breeders, Mauland, of Gimle near Stavanger, had tried pure breeding of these sheep. He had used two Gromet rams which we shall call Number 1 and Number 2. Ram Number 1 was bred to a Gromet female and produced three Gromet lambs. By breeding ram Number 2 to eight Gromet females twenty Gromet lambs were produced. Both rams and most of the females were born from white parents. Further, ram Number 1 was bred to two white Cheviot females and produced two white lambs. He was also bred to two black-faced females and produced two black lambs without the Gromet pattern. By two white females from Gromet mothers he produced two Gromet lambs. Mating him with a black ewe produced one greyish lamb with Gromet markings.

Ram Number 2 was bred with two Cheviot females and gave two white lambs. A Gromet female mated to a white Cheviot ram produced one white lamb.

Another breeder, Gausland I. Klepp of Rogaland, mated a Gromet ewe with a white ram and obtained one Gromet and one white lamb. The same ram bred to a white female produced a black lamb with Gromet pattern.

By mating a black-faced ram and a Gromet ewe he obtained two black-faced lambs without the Gromet pattern.

Tabulating these results we have:

Matings	Offspring	
	Gromet	Non-Gromet
Gromet × Heterozygote....	3	1
Gromet × Gromet.....	23	0
Gromet × Non-Gromet.....	0	9

Considering the common occurance of Gromets in white flocks it is obvious that this marking is based on a simple Mendelian factor recessive to ordinary white. From the few data presented it appears that the Gromet marking behaves in the same way in the presence of the factor that produces black-faced lambs.

URBANISM BREEDS WAR

The mental factors developed with hunting and fishing habits could not be utilized to any extent under an agricultural regime, but they did not pass out of human history an utter loss. As has been pointed out by John Dewey, they found new expression. In the words of present-day psychology they were sublimated. In place of hunting animals for food, and other humans for the satisfaction of killing them, new forms of pursuit originated. When the development of agriculture reached a stage that permitted the gathering of such a surplus of food as made possible the city with a population dependent upon outside support for sustenance, then the spirit of the hunt was given an adequate vocational expression by the pressure and competition of urban life. Business especially offered the zest and struggle and even the craft of the hunter's life. The dramatic appeal of primitive life was more than matched by the satisfactions of commercial competition. Even the pleasure of contests with the enemy was provided by the antagonisms of classes.

The ancient handicap of the agricultural vocation still remains. From a hunter's point of view it is even yet a prosaic occupation and in large measure likely so to continue. It has a dramatic element in the never-ending struggle of the wits of man against the untoward happenings of season and climate, but the average imagination cannot grasp this form of contest so easily as it does the spectacular conflicts furnished by the commercial strife of man against man in the cities.

The theory has been advanced that this difference in the appeal of country and city vocations has tended toward an ethnic stratification in Central Europe. The head shape that characterizes the Teuton racial type, it is claimed, is more commonly found in the urban population, the broad-headed representative of the Alpine race being predominantly rural. In this stratification of race head forms are included mental traits. The Alpine type is defined as rural-minded, tenacious in its grip upon the soil. It represents conservatism and is indisposed to migrate. To this racial type belongs the peasant. On the other hand the mobile Teuton, the long-headed type, loves the city with its opportunity for energetic competition and for dominance. Therefore, when within any territory there is a considerable mingling of the two races, he furnishes the greater part of the urban population. This theory, which is by no means an established fact of science, calls attention to the natural attractiveness of the city for the more pugnacious and domineering individuals of a population. Those who are by instinct fitted for a struggle with persons must seek urban conditions for their highest social satisfaction. The other type, on the contrary, firm in a primitive love for the soil and well equipped for a patient but ceaseless contest with nature, is most at home in the small village or open country.

The hunter has by no means limited

himself in modern life to business and class competition. The mental cravings typical of the hunter find frequent and periodic expression in warfare. How deep these cravings are and how persistent is clearly shown by the large place war holds in the record of modern history. Since the first appearance of agriculture human nature has suffered a social dualism. The hunter-warrior's impulses have made for war; the shepherd-farmer's for peace. The average modern man finds himself impelled toward the captivating emotional orgasm of war and also toward the pleasures and opportunities of the orderly and productive life of peace. The normal influence of rural experience tends toward peace and attainment of satisfaction by productive labor. The urban mind is more easily inflamed into the war mind and started upon a violent career. War draws out the impetuous impulses of the hunter's disposition, and with the return of peace the citizen turns to ordinary occupations with relief. It is in terms of war, however, that he still expresses his profound political loyalty, and from war experiences that he constructs his strongest traditions. As the agriculturists little by little narrowed the hunter's territory by bringing the soil under permanent cultivation, so the social mind originating from the farming experience makes slow headway against the powerful appeal of war upon man's most primitive and irrational cravings. (*The Rural Mind and Social Welfare,* by E. R. Groves, Pp. 19-22. Chicago University Press.)

If it be a crime, then lead me to jail: the fact remains that I long for the gaudy diversion of another war, and hope that it is not too long delayed. The last one provided a show that was precisely to my somewhat florid taste; I emerged from it profoundly thankful to Providence for letting me serve my term in the world in such an era—the most astounding and amusing since that of the Crusades. Now, on rainy days, I find myself pining for its incomparable entertainment. I long for the black, Gothic headlines on the front pages; for the romantic *communiques* of the French General Staff; for the photographs of German lieutenants feeding Belgian infants into sausage-machines; for the daily bulls and ukases of the eloquent Woodrow. . . .

But the list must have an end, though it is really endless. Those were happy, electric days—the dullest of them better than circus day, even than hanging day. I enjoyed them vastly. They sent me to bed in a glow and got me up in the morning with all the eager expectancy of a schoolboy entering a Museum of Anatomy. I say frankly that I hope they will return. I long to see the American Legion. bonus in pocket, marching off to another war.—*The American Mercury,* March, 1924.

A LIBRARY OF EUGENICS

A Review

PROCEEDINGS OF THE SECOND INTERNATIONAL CONGRESS OF EUGENICS, New York, September 22-28, 1921: Volume I, EUGENICS, GENETICS AND THE FAMILY. Pp. x+472, 20 full page plates and many text figures. Volume II, EUGENICS IN RACE AND STATE. Pp.x+472, 20 full page plates and many text figures. Price, either volume, $6; both volumes, $11. Williams and Wilkins, Baltimore, 1923.

THE SECOND INTERNATIONAL EXHIBITION OF EUGENICS, an account of the organization of the exhibition and a classification and list of the exhibits, etc. by HARRY H. LAUGHLIN, Pp. 155, 47 full page plates. Price $3. Williams and Wilkins. Baltimore, 1923.

Publication of the Proceedings of the Second International Congress of Eugenics, held in New York in September, 1921, is an event of great importance. It can even be compared with the publication of Galton's pioneer work, which gave a name to Eugenics, and laid the foundation for the structure that is now being built. What greater testimony or assurance of the value of Galton's work could be asked than the contribution, from many nations of the world, of such a great number of thoughtful and carefully written papers as the Congress brought together?

Many of these papers deal with fundamental aspects of the subject, and are worthy of review as separate contributions. Indeed, the two volumes should be considered rather as a library than as a single work. Dozens, or even hundreds of individual books that have been published on the subject since Galton's time might be collected without bringing together such a well balanced library, containing as much intelligent thought and authentic data as these volumes afford. The general reader may well profit by the fact that many of the contributors have shortened and simplified their material as much as possible in preparing to present it verbally. Even the unscientific reader will find it well worth his while to learn of the great variety of facts now being discovered that have an important relation to eugenics. Such knowledge is much needed by the general public, who sense the need of eugenic reform, but lack the biological background necessary to escape the premature generalizations of the faddists.

How eugenics is being studied, and the need for intensive research work in laboratory and clinic is valuable knowledge for all those who are writing the well-intentioned but largely mistaken books and articles on the subject that appear so frequently. This need for more information might be taken as a keynote of the volumes—the facts that are here presented being only a beginning. As one of the contributors has put it: "Our opponents generally say that we should wait to take eugenic measures *in general* and steps against racecrossings *especially* until we have more knowledge. I admit that we need and shall seek more knowledge, *much* more knowledge! But —as our experience to date points decidedly in one direction it will be safer to turn the matter around and say: *Until we have acquired sufficient knowledge, be careful!*"

As the best means of showing the nature and extent of the material contained in these volumes we are giving a complete list of the contributions, arranged alphabetically by authors for ease of reference:

Volume I
Eugenicas, Genetics and the Family

ANDERSON, W. S. The Effect on the Germ Plasm of Isolation in a Mountain Section.

BAGG, HALSEY J. Disturbances in Mammalian Development Produced by Radium Emanation.

BANTA, ARTHUR M. and L. A. BROWN. Some Data on Control of Sex in Cladocera.
BANKER, HOWARD J. The Learned Blacksmith—An Aristogenic Type. 2. The Ideal Family History.
BELLING, JOHN. The Attraction Between Homologous Chromosomes.
BLAKESLEE, A. F. Variation in Jimson Weed.
BONNEVIE, KRISTINE. Main Results of Statistical Investigation of Finger Prints from 24,518 Individuals.
BRIDGES, CALVIN B. Aberrations in Chromosomal Materials.
BUTLER, AMOS W. Some Families as Factors in Antisocial Conditions.
COTTON, HENRY A. Inheritance in Mental Disorders.
CUENOT, L. Genetique et Adaptation.
DANFORTH, H. C. The Frequency of Mutation and the Incidence of Hereditary Traits in Man.
DARWIN, LEONARD. Aims and Methods of Eugenical Societies.
DAVENPORT, CHARLES B. Research in Eugenics.
ESTABROOK, ARTHUR M. The Tribe of Ishmael.
FISHER, R. A. Darwinian Evolution by Mutation.
GATES, R. RUGGLES. A New Type of Variability in Plants.
GREEN, ELIZABETH. A Study of 150 Adolescent Runaways.
HOWE, LUCIEN. Inheritance of Eye Defects.
HURST, C. C. Genetics of Fecundity in the Domestic Hen.
IZQUIERDO, J. JOAQUIN. Breve Resena Genealogica de la Familia Izquierdo.
JENNINGS, H. S. Inheritance in Uni-cellular Organisms.
JOHNSON, ROSWELL. Mate Selection.
KEY, WILHELMINE. Heritable Factors in Human Fitness and Their Social Control.
KIMBALL, SARAH LOUISE. The Mayflower Pilgrims.
KING, HELEN DEAN. Is Inbreeding Injurious?
LEGRAND, LOUIS. A Simple Explanation of the Hereditary Mechanism.
LEWIS, PAUL A. The Relation of Heredity to Tuberculosis.
LIDBETTER, E. J. Pedigrees of Pauper Stocks.
LOEB, LEO. The Inheritance of Cancer in Mice.
LITTLE, C. C. The Inheritance of a Predisposition to Cancer in Man.
MCCLUNG, C. E. The Evolution of the Chromosome Complex.
MACDOWELL, E. CARLTON. The Genetic Significance of the Alcoholic Treatment of White Rats.
MARCH, M. LUCIEN. The Consequences of the War and the Birthrate in France.
MARTIN, RUTH MOXCEY. Intermarriage of Blood Relatives in Three Old New England Communities.
MULLER, H. J. Mutation.
NOYES, HILDA H., and GEO. W. The Oneida Community Experiment in Stirpiculture.
OSBORN, HENRY FAIRFIELD. Address of Welcome.
RABAUD, M. ETIENNE. Development Comparé des Produits Successifs d'un meme couple.
ROSANOFF, AARON J. Inheritance of Mental Disorders.
SEASHORE, CARL E. Individual and Racial Inheritance of Musical Traits.
SHULL, A. FRANKLIN. Sex Determination in Rotifers.
SHULL, GEORGE H. Linkage with Lethal Factors as the Solution of the Oenothera Problem.
SPINDEN, HERBERT J. Formal Inbreeding in Human Society, with South American Examples.
STANTON, HAZEL M. An Experimental Investigation of Musical Inheritance.
TERRY, R. J., and LEE D. CADY. Comparison of the Incidence of the Supracondyloid Process in Groups with Normal and Subnormal Mentality.
WRIGHT, SEWELL. The Effect of Inbreeding on Guinea-Pigs.
WOODS, FREDERICK ADAMS. The Conification of Social Groups.

Volume II

Eugenics in Race and State

ADAMI, GEORGE. The True Aristocracy.
AHLUWALIA, GOPLJI. The Hindu Ideal of Marriage.
BALDWIN, BIRD T. The Scientific Prediction of the Physical Growth of Children.
BEAN, R. BENNETT. Notes on the Body-Form of Man.
BEDWELL, C. E. A. Eugenics in International Affairs.
BILLINGS, W. C. Medical Application of the Immigration Law.
BINDER, RUDOLPH M. Health and Eugenics.
CALHOUN, ARTHUR WALLACE. The Economic Factor in the Problem of Eugenics.
DARWIN, LEONARD. The Field of Eugenic Reform.
DILLA, HARRIETTE M. Control of Parenthood in Relation to Eugenics.
DUBLIN, LOUIS I. The Higher Education of Woman and Race Betterment. 2. The Mortality of Foreign Race Stocks.
DUNN, L. C. Some Results of Marriage Mixture in Hawaii.
EAST, E. M. Population in Relation to Agriculture.
FISHBERG, MAURICE. Intermarriage Between Jews and Christians.
FAIRCHILD, MILTON. Pure Science Work in Higher Eugenics.

FISHER, R. A. The Evolution of the Conscience in Civilized Communities in Special Relation to Sexual Vices.
FRASSETTO, FABIO. Height-Weight Index of Build or Robustness. 2. Other Forms of the Law Governing the Relation Between Stature and Weight in Adults.
GINI, CORRADO. The War from the Eugenic Point of View.
GIUFFRIDA RUGGERI, V. The Height-Weight Index of Build Amongst the Italian Adolescents of Fifty Years Ago.
GROZMANN, M. E. P. Some Limitations to Present Theories.
HASKOVEC, LADISLAY. The Eugenics Movement in the Czecho-slovak Republic. 2. The Problem of Negro-White Intermixture and Intermarriage.
HOLMES, S. J., and J. C. COFF. The Selective Elimination of Male Infants Under Different Environmental Conditions.
HOOTON, E. A. Observations and Queries as to the Effect of Race Mixture on Certain Physical Characteristics.
IRELAND, ALLAYNE. The Nature-Nurture Issue in Its Bearing on Government.
JOHNSON, DYMPLE BRYANT. The Life Stories of a Class of 27 High School Graduates in Relation to Longevity and Social Progress.
KNOPF, S. ADOLPHUS. Eugenics in Its Relation to the Tuberculosis Problem.
KOEGEL, OTTO E. Common Law Marriage and Its Development in the United States.
LAMPOUGE, G. V. DE. La Race chez les populations melangees.
LAUGHLIN, HARRY H. Nativity of Institutional Inmates. 2. The Present Status of Eugenical Sterilization in the United States.
MALLET, BERNARD. Registration in Relation to Eugenics.
MCDOUGALL, WM. A National Fund for a New Plan of Remuneration as a Eugenic Measure. 2. The Correlation Between Native Ability and Social Status.
MJOEN, JON ALFRED. Harmonic and Disharmonic Race Crossings.
NACCARATI, SANTE. The Morpholgic Characteristics of Esychoneuroses.
PATON, STEWART. Medicine's Opportunity.
PEARL, RAYMOND. Some Eugenic Aspects of the Problem of Population.
POLLOCK, HORATIO. Eugenics as a Factor in the Prevention of Mental Disease.
POPENOE, PAUL. Eugenics and Islam.
RADOSAVIJEVICH, PAUL R. Eugenic Problems of the Slavic Race.
RAMOSE, D. F. Homiculture in Its Relation to Eugenics in Cuba.
ROBINSON, DAISY M. O. Heredity and Venerial Disease.
RUZICKA, VLAD. The Significance of Causal Research in Eugenics. 2. A Motion for the Organization of Eugenic Research.
SADLER, WILLIAM S. Endocrines, Defective Germ-Plasm and Hereditary Defectiveness.
SALAMAN, REDCLIFFE N. Some Notes on the Jewish Problem.
SALEEBY, C. W. Preventive Eugenics—The Protection of Parenthood from the Racial Poisons.
TREDGOLD, A. F. Educability and Inheritance.
VICARI, E. M. Hybridization and Behavior.
WILCOX, W. F. Distribution and Increase of Negroes in the United States.
WOLFE. Eugenics and Social Attitudes.

Though not of as much interest to the general reader, the volume describing the Second International Exhibition of Eugenics should be of great value for reference purposes. It contains a catalog and description of all the exhibits at the Congress, together with a list of the exhibitors. The forty-seven full page plates show the exhibition hall and some of the more important exhibits. This volume should be invaluable to anyone who has charge of getting together an exhibit of this kind.

A Gregor Mendel Memorial Publication

Announcement has been received of the publication of a volume of four hundred pages which is being issued in connection with the Gregor Mendel centennary celebration at Brunn. The book is devided into two parts; an editorial section, written in Latin, and a section devoted to the contributions of twenty-four geneticists. These are written in the languages used by the respective contributors, who come from Europe, America, and Japan. Some of these papers present summaries and historical outlines of progress in genetics, and others report the results of specific investigations.

The "Studia Mendeliana" is richly illustrated with numerous plates and text figures. The price is fifty kronen, or a dollar and a half. It is for sale by the publishers, "Typos," Brno, Czecho-Slovakia, Rennenstrasse 22.

A GROWTH DISORDER OF STRAWBERRIES ASCRIBED TO NEMATODES

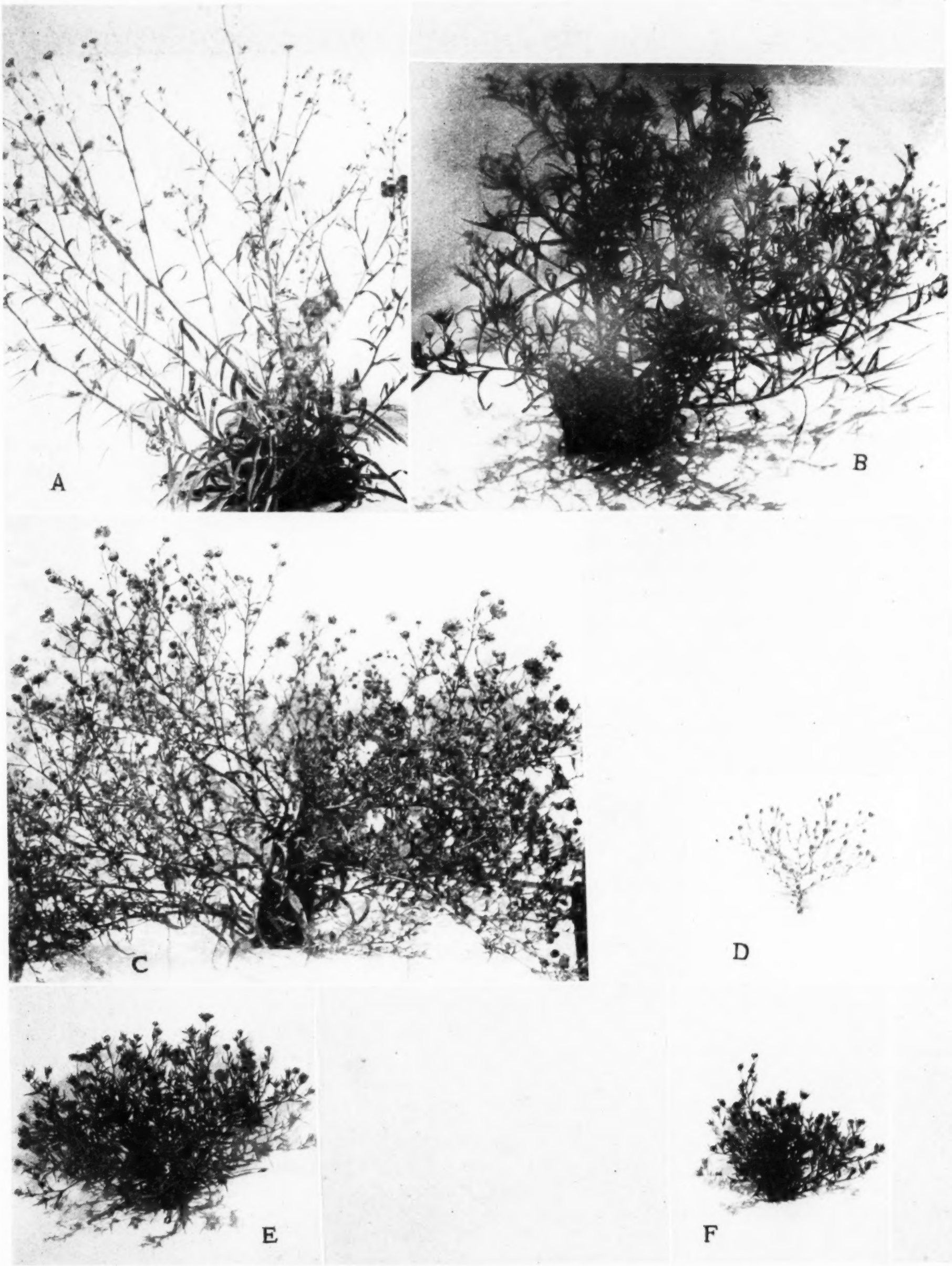
A possible relation of nematodes to growth disorders of plants is indicated in the *Journal of Pomology and Horticultural Science* for September, 1923, in an article by E. Ballard and G. S. Peren, entitled "Red Plant in Strawberries and its Correlation with 'Cauliflower Disease'." Among the symptoms of the "Red Plant" disease a wide range of deformities is described and illustrated, apparently quite analogous to those that have appeared in growth disorders of cotton, as described in the JOURNAL OF HEREDITY for March, 1920, and October, 1923.

"The chief feature of afflicted plants is the deep blood red coloration of the young petioles and the under sides of the unfolding leaflets," but the color symptoms are not always present, even when the growth is very abnormal. The malformation symptoms include notable reduction, distortion or crumpling of the petioles and leaflets, enlargement of the stipules, and abnormality of branching. The flowers and inflorescences are deformed, and "frequently the scape is much fasciated." The formation of lateral crowns may be entirely inhibited, while in other cases "excessive crown formation begins and is continued until a dense mass of leafage is produced."

The authors conclude that the whole range of abnormal behavior recognized under different names as "Red Plant," "Cauliflower" and "Small Leaf," forms a connected series, which is associated with the presence of an eel-worm, *Aphelenchus fragariae*, in the growing points of the affected plants. The worms "can always be found . . . between the developing leaf rudiments, on each side of the growing point." It is inferred that the differences of behavior are "either different types of reaction on the part of the plant to the same noxious stimulant, or different degrees of infection, or again the result of infection contracted at different stages of growth." Also it would seem that the reactions of the plants to the disease might be determined to a large extent by differences of external conditions, as with other growth disorders, including mosaic diseases.

The relation of the strawberry disease to the eel-worms was inferred from "an examination of a large amount of material which we had at our disposal from several different districts," apparently material that was sent for laboratory examination. It is not stated that normal plants from the same field were examined and found to be free from nematodes, nor is there a statement of the distribution or the mode of occurrence of the disease under field conditions. A sporadic occurrence may be indicated by the suggestion that "careful rogueing and burning of affected parent plants cannot fail to assure a considerable reduction." Fifty varieties have been examined, but no immunity was found.

That mosaic or mosaic-like diseases might be caused or conveyed by nematode parasites as well as by plant-lice, leaf-hoppers or mites, is a possibility to be recognized in the investigation of such disorders. Nematodes are known to be responsible not only for root-galls, but for many other abnormalities of shape, size and color in different families of plants. Injuries may be caused directly by secretions or excretions of the nematodes, or by infections with disease organisms. The roots of plants might be infected, or the nematodes might be conveyed by insects or birds. As the authors recognize with the strawberry disease, "The life-history of the eel-worms, the methods of infections and possibilities of contact all remain to be studied."



VARIATION IN SIZE OF CITRINA TARWEED PLANTS

FIGURE 16. Two plants of the first generation raised in the garden are shown at *A* and *B*. They are nineteen and fifteen inches high respectively. *C* and *D* are the largest and the smallest plants in the progeny of *A* and *B*, and are fifteen and six inches high. The next generation is not illustrated, but the three plants averaged less than fourteen inches in height. Two of them were crossed and produced a family of eight plants, averaging less than eight inches in height. Two of these are shown at *E* and *F*.

REMARKABLE VARIATIONS IN TARWEEDS

Many Abnormalities Found in Plants Long Domesticated Appear in First Generation Raised in Garden

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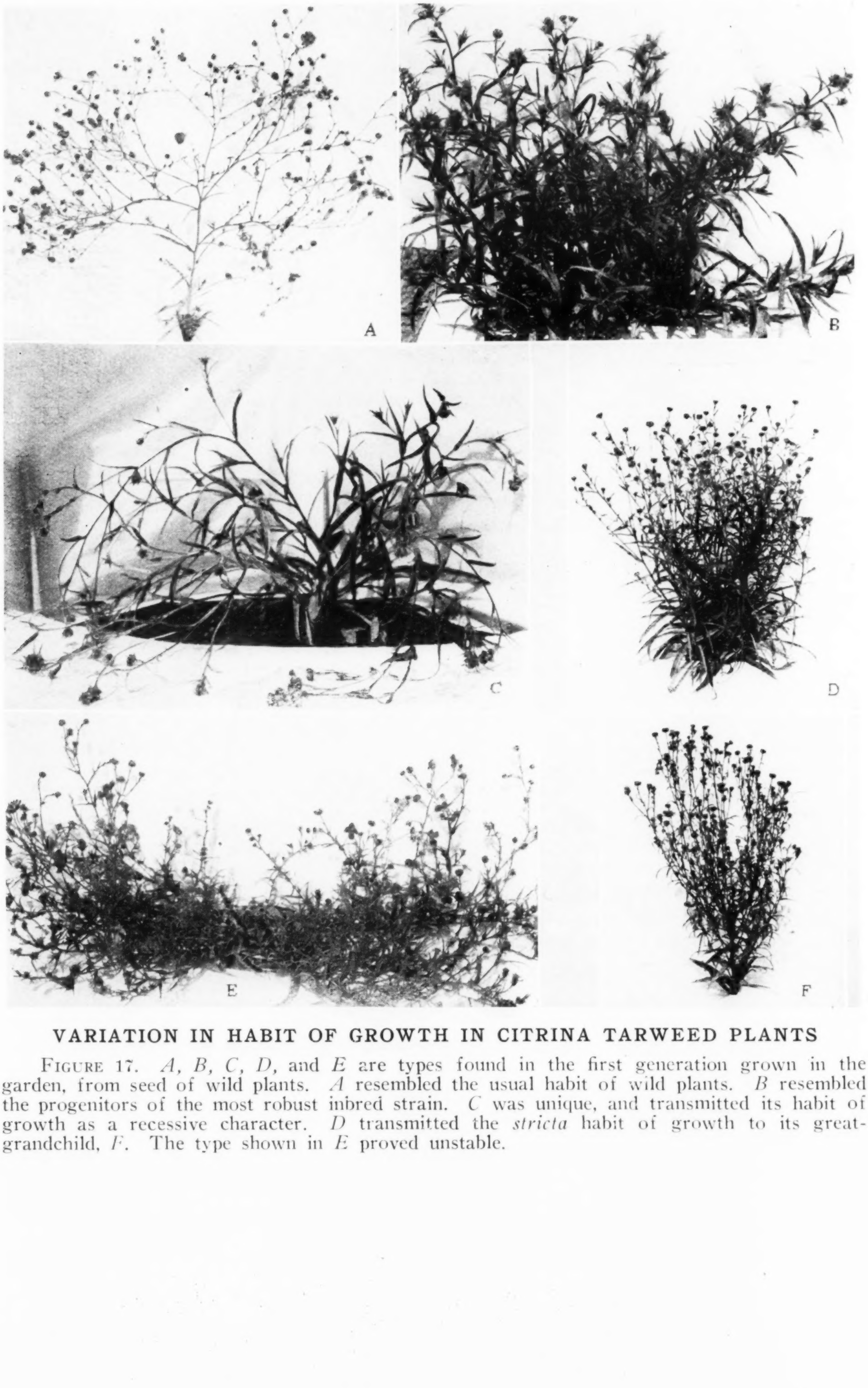
DURING the course of a genetical investigation of two of the Hayfield Tarweeds* a number of interesting variations have appeared among populations only one, two, three, or four years removed from the wild state. Some of the variations which were found among about 400 plants *during the first season of garden culture* are the following: Size of plant, habit (form) of plant, color of flowers (corolla and stamen tube), structure of flowers (petallody), size of leaves (width and length), pubescence on leaves (long, appressed or short, spreading), and other less striking differences. From the first year garden cultures numerous pairs of plants were chosen and crossed because the individual tarweed, like the individual sunflower, is self-sterile. From their progeny similar pairs were again chosen and crossed, and this was repeated, so that inbreeding by brother and sister mating was practiced in some strains for two or three years, when these strains became so weakened that very few progeny were obtained. It was in these inbred strains that most of the other variations herein described were found.

Variations in Size of Plants

There is considerable variation in the size of wild plants of these forms, but probably such extreme differences as appeared in the garden would seldom occur in nature. This would be expected because in the garden nearly every seedling is preserved and each is given an opportunity to develop to the limit permitted by its hereditary determiner (genotype). Many different genotypes as regards size of plant would occur among the wild plants, if there were several Mendelian factors which condition growth and a number of other factors which modify growth and vigor. It must be remembered that a single plant is self-sterile, so that every fertile seed is the result of crossing two plants, a situation which provides for the maximum amount of heterozygosity within the population.

The differences in size of plant found in the first garden culture of *citrina* were greater than is indicated in Figure 16, *A, B,* but these plants are illustrated because of the size differences among their progeny. Much more striking differences in size appeared the second year in the garden as a result of segregation of size factors. This is shown in Figure 16, *C, D,* which were progeny of the same parents, Figure 16, *A, B*. Furthermore the general result of inbreeding was to cause reduction of size and vigor and loss of reproductive power. Thus Figure 16, E and F, are members of the same family after two generations of inbreeding, and they represent about the average of the eight plants in the family. One inbred strain, however,

*The taxonomic status of these two and related forms will be discussed in another place. Both should be included in the collective species, *Hemizonia congesta,* although one has received the name, *H. citrina* Greene and the other, *H. rudis* Benth. For the sake of brevity the two forms treated in this paper will be referred to as *citrina* and *rudis*.



VARIATION IN HABIT OF GROWTH IN CITRINA TARWEED PLANTS

FIGURE 17. *A*, *B*, *C*, *D*, and *E* are types found in the first generation grown in the garden, from seed of wild plants. *A* resembled the usual habit of wild plants. *B* resembled the progenitors of the most robust inbred strain. *C* was unique, and transmitted its habit of growth as a recessive character. *D* transmitted the *stricta* habit of growth to its great-grandchild, *F*. The type shown in *E* proved unstable.

did not follow the usual course, but instead displayed increased vigor during three generations of inbreeding and developed certain remarkable abnormalities in structure of the flowers (see Figure 21). Several of the inbred strains also produced some seedlings with retarded development, some of which failed to reach maturity, while others produced tiny plants one or two inches high bearing two or three flower heads, and others grew somewhat larger. Similar variations in size of plants were found in the other subspecies, *rudis*. Thus it appears that there are many genetic factors which determine or influence size and vigor of the plant in these tarweeds, and that, in a wild population, any two plants which happen to look quite similar may possess either similar or different size factors with resulting similarities or differences among their progenies when tested in the garden or subjected to inbreeding.

Variations in Habit or Form of Plants

In wild plants of these species the single erect stem is usually branched above, somewhat as in Figure 17, *A*, so that the flowers are lifted above the grass or stubble, among which the plants usually grow. The diversity of habit found among the plants of the first garden generation was truly remarkable. Some of the most striking types are shown in Figure 17, *A-E*, all of which appeared in the first garden culture of *citrina*. Many of these first season's plants had the slender, wiry stem and branches seen in Figure 17, *A* and *C*, but others had the robust, succulent appearance, the many branches, and the pronounced leafiness of Figure 17, *B*, and it was from two such plants as the latter that the robust inbred strain mentioned above was derived. The procumbent habit exhibited by the plant shown in Figure 17, *C*, was inherited as a Mendelian recessive character. The next plant, Figure 17, *D*, was a great-grandparent of the one just below, Figure 17, *F*, which is of the *stricta* type. This type of habit breeds true and behaves as a Mendelian character. In Figure 17, *E*, is shown the short-stemmed spreading habit which proved to be unstable and is the expression of a heterozygous genotype. Thus we find that the Hayfield Tarweeds, when removed from their usually crowded and often semiarid environment, are capable of producing a striking array of plant forms. Some of these forms, particularly the procumbent habit (Figure 17, *C*,), would tend to be eliminated by natural selection in the wild state, but the recessive factor conditioning it would occur in heterozygous combination among a certain number of the wild plants, so that plants of this habit would be expected to appear from time to time. Other forms, such as *stricta*, would tend to be preserved and to segregate out from time to time, although often partially masked by the influence of the environment or of other factors as in Figure 17, *D*. The masking of the potential genetic qualities of these plants both by their rigorous natural environment and by the heterozygous condition is of considerable interest to taxonomists as well as to plant breeders.

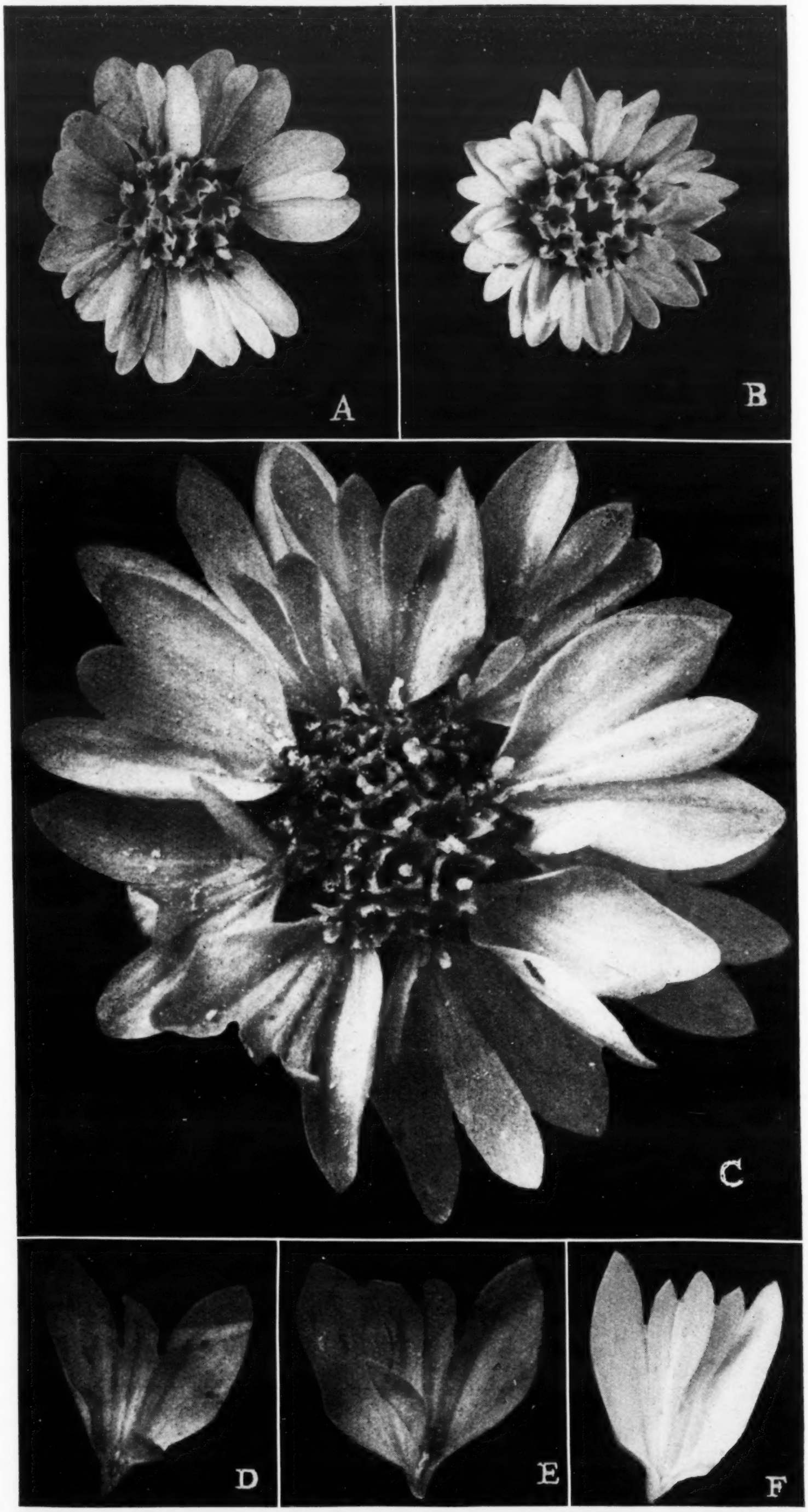
It is noteworthy, too, that, although the first garden cultures of *rudis* were fully as extensive as those of *citrina*, and although all the *citrina* plants were grown from seed collected from a few plants in one spot, while the *rudis* cultures came from seed collected in several widely separated localities, yet the *rudis* cultures were more uniform as regards habit of plant than were the *citrina*. There were only two definite habit types among the *rudis* plants with minor variations, while the *citrina* population contained the five types shown in Figure 17 and others less striking. This difference may have some phylogenetic significance.

Variations in Color of Flowers in Citrina

The conspicuous portion of the flower head in these plants is the outer circle of ligules or rays, which in the wild plants are bright yellow of the

THE "COLLARETTE" TARWEED

FIGURE 18. Below is shown one head from a plant of the collarette type of *citrina*, with all but three of the ray flowers removed. Note the posterior erect lip in each corolla. In the upper left-hand corner is shown a similar corolla attached to its achene (seed). Opposite it in the right hand corner is shown another two-lipped corolla seen from above, showing the two lobes of the posterior lip. Between these is shown another ray flower from the same head, lacking the posterior lip, but with a small extra lobe on the left side of ray. (Enlarged four times.)



DOUBLE RAY FLOWERS IN TARWEEDS

FIGURE 19. *A*, normal flower head of *rudis*; *B*, head from *rudis* plant in first garden culture, showing two extra petal-like organs within each ray; *C*, a head of *citrina*, considerably enlarged, showing petallody in some of the rays; *D*, a normal three-lobed ray; *E*, a four-lobed ray; *F*, a five-lobed ray, each containing one petal-like organ. *A* and *B* are enlarged about one and one-half times; *C* about three times; and the others about two and one-half times.

degree called lemon chrome in Ridgway's *Color Standards and Nomenclature*. Slight variations appear among wild plants, and by sufficient searching one would probably discover the more extreme variations which appeared in the garden cultures. The next lighter color than lemon chrome (illustrated in Ridgway) is lemon yellow, and this was noted in two or three plants in the first garden generation. One of these (Figure 16, *B*) was crossed with another (Figure 16, *A*) whose flowers were lighter than lemon chrome (probably Ridgway No. 22, which comes between lemon chrome, No. 21, and lemon yellow, No. 23, but is not illustrated), and among the seven offspring secured four had lemon chrome, two had lemon yellow, and one, pale lemon yellow flowers (23b). The progress made during three generations in attempting to establish a strain of *citrina* with very pale yellow flowers is summarized in Table I. In the same table the reduction in size of plant as a result of only two generations of inbreeding is also shown. It will be noted that in F_3 three of the eight plants had flowers that were lighter than the pale lemon yellow of Ridgway, but that all eight plants were so small and few-flowered that inbreeding could not be longer continued. Accordingly, this strain was outcrossed to a strain with lemon chrome flowers. As a result of this experiment it became evident that there are several factors for the yellow color of the rays in *citrina*. This is further indicated by the results of crossing *citrina* with *rudis* which has white rays, except for a reddish purple tinge on the outside of the ray in some plants. The flowers of the F_1 generation plants were intermediate in color, and in the F_2 generation nearly all of the 181 plants bore flowers of some intermediate shade—only one being recorded as having lemon chrome rays and none with pure white ligules, although three or four plants had flowers of a very pale greenish yellow tint.

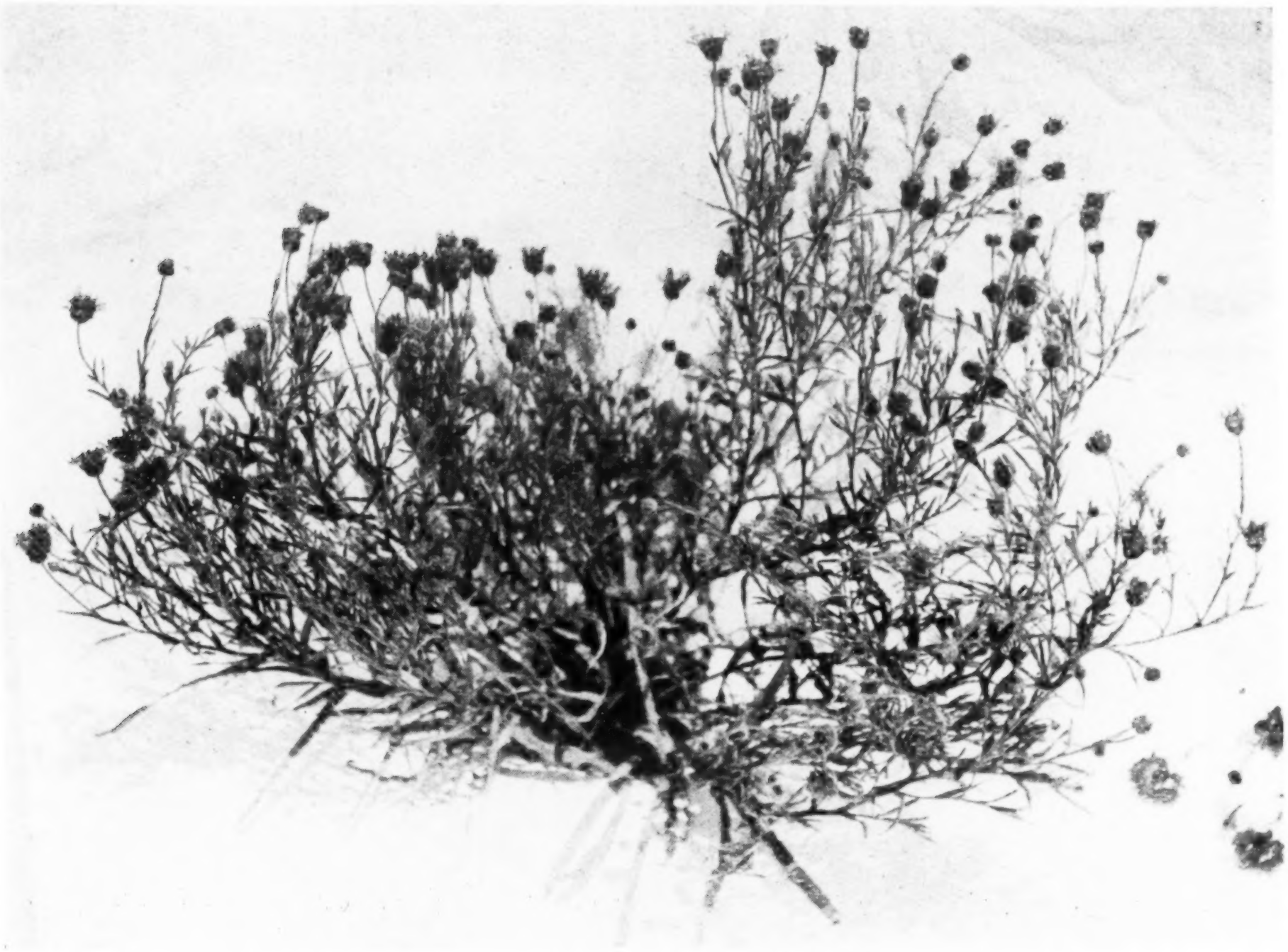
LEAF-LIKE BRACTS IN THE FLOWER-HEAD

FIGURE 20. Note the foliaceous bracts developing *inside* the circle of ray-flowers. Such a head is shown in Figure 21, after branches have developed from the region of these bracts. The occurrence of so many variations in the early generations raised in the garden shows that many of the abnormal plant forms developed by man are present in the wild stock, only awaiting selective breeding to bring them to light.

Another color variation was discovered in one plant of the first garden generation, viz., cream stamen tubes. Usually the stamen tube is a deep purple color, but in this one plant there was no purple color present in the stamen tube. This character was inherited as a simple Mendelian recessive.

PROLIFERATION OF INFLORESCENCE

FIGURE 21. This shows a head similar to that shown in Figure 20, after it has been covered with a paper bag for some weeks. The whorl of branches has developed from the outer region of the flower disc, but within the circle of ray flowers, which are normal and fertile. Natural size.



A CHIMERICAL, VIRESCENT TARWEED PLANT

FIGURE 22. The five branches forming the right-hand portion of this *citrina* plant were several inches longer than the remaining ones. All of the flowers were abnormal and sterile, with virescent (green) flower parts. See Figure 23.

Variations in Structure of Flowers

Petallody. In the first garden culture of *rudis* one plant was found with "double ligules" due to the development of petal-like structures within and near the base of the corolla-tube (Figure 19, *B*). Among twenty-five seedlings of this plant (from unguarded seed) one was found which exhibited petallody in part of its ray flowers. It was crossed with a normal sib, and among the eighteen seedlings obtained there was one which displayed an extreme form of petallody. From such slender evidence no conclusion can be reached as to the mode of inheritance of this interesting variation, but that it is inherited seems fairly certain. Later this teratological form appeared occasionally in *citrina* (Figure 19, *C-F*). It is probable that in a species more amenable to inbreeding it would have been possible to secure a strain with "double ligules."

Collarette. (Figure 18). This striking type of flower head, so named because of its similarity to the well-known Collarette Dahlia, first appeared after two generations of inbreeding in a strain selected for the *stricta* type of habit. Nothing unusual had been noted about the flower heads, except that the rays were in two rows, a not uncommon condition. This sudden appearance of a character new to the species simulates mutation, but a little consideration of the circumstances leads to the conclusion that it was due to a fortuitous combination of genetic factors and is reversionary in nature. This view is strengthened by the fact that one of the prototypes of the Com-

NORMAL AND VIRESCENT TARWEED FLOWERS

FIGURE 23. *a*, Normal flower head and bud of normal citrina; *a'*, normal ray flower with achene surrounded by involucral bract; *a''*, normal disc flowers. *x*, flowers from plants shown in Figure 22; *x'*, ray flowers from this plant, the left one with involucral bract; and *x''*, the disc flowers. Instead of the normal ray flowers, green foliaceous bracts have developed.

positae is believed to have had a five-lobed, bilabiate corolla. In this connection it is of interest to note that of the three individual florets shown in Figure 18, the right-hand one has its posterior lip notched at the top, thus producing a five-lobed corolla. This, so far as the writer is aware, is the first time the bilabiate type of corolla has been reported in the Tarweed Subtribe (Madinae) of the Compositae.

Corolla Lobes. Variation in the number of lobes in rays which were otherwise normal was also worthy of note. As is shown in Figure 19, *A, C,* the normal number is three, but in several of the strains, including those showing petallody, rays with four and even five lobes occur, Figure 19, *E, F.* Reduction in the number of lobes was characteristic of certain other inbred strains of *citrina*, particularly those having lighter flower color. This tendency became so marked after one generation of inbreeding that the descriptive name *biloba* was added. In every case reduction was accomplished by omission of the middle lobe.

Corolla-Tube. In the normal ray flowers the corolla is tubular only at the base (Figures 18 and 19), but in one of the first *stricta* plants showing the collarette type in some of the rays, other rays were found in which the tubular portion was half the length of the corolla. This type of variation occurs frequently in the common Gaillardia and other cultivated species of the Compositae.

Proliferation and Virescence

After one generation of inbreeding in one of the robust strains of *citrina* a family was produced in which all of the plants were exceptionally late in maturing but remarkably vigorous. When these plants began to flower, it was found that, in some heads at least, only the ray flowers were normal. Instead of disk flowers foliaceous bracts developed, as shown in Figure 21. Later a whorl of branchlets appeared around the margin of the disk and inside the whorl of rays (Figure 20). Similar cases of proliferation have been found in the common marigold.

In Bisset's report of such a case* he attributes the abnormality to environmental conditions but states that it appeared on *several* of the plants. As the plants seem to have been grown under uniform greenhouse conditions, it may fairly be questioned why it did not appear on *all* the plants, if it were due merely to over-stimulation, as Bisset assumes. In view of the present evidence it seems more probable that the plants which exhibited prolification were different genetically from those which did not. It is possible, of course, that the prolificated plants would not have developed the abnormality under ordinary garden conditions, and, if so, the expression of their genotype was conditioned by their environment. But the writer has seen the same abnormality in the same plant when grown in the garden without special care, and the same type of abnormality is found occasionally even in wild plants.

For example, I have in my possession prolificated specimens of *Erodium moschatum*, a common native forage plant of California. These were collected by Mr. Joseph P. Tracy of Eureka, who wrote as follows: "This is a "freak" form, its peculiarity being in a tendency of the umbels to be compound, i. e., to produce secondary umbels or small branches, instead of the usual, few, short-pedicelled flowers. I first noted this form in a single plant in the spring of 1911 on G Street, where I pass daily going to and from work. This spring, 1912, there were many plants scattered for half a block." There can be no question as to a genetic cause for this case of prolification, any more than there can be for the tarweed case described above. It may be inferred, therefore, that such abnormalities

*Bisset, P. Prolification in a double-flowered form of *Calendula officinalis*. *Jour. Hered.* 9: 323-325. 1918.

always depend upon a germinal change or difference of some sort, although the manifestation of that germinal condition may in turn depend upon the environment.

Two plants with virescent flowers have been found during six years' observations on hundreds of plants, one being *citrina,* the other, *rudis.* The former is shown in Figure 22, as this plant had the additional peculiarity of being chimerical. All of the branches on one side of the plant were several inches longer than the remainder. All of the flowers were virescent and proliferous, both ray and disk flowers being much elongated (Figure 23). The ovary when present was about one-fourth inch long and greenish. The ray flowers were tubular, sometimes being partially expanded into a greenish yellow ligule. The style and stigma were usually present and apparently normal. The disk flowers were two to four times the normal length and virescent; the anthers were brownish instead of purple and apparently devoid of pollen.

Conclusion

It has long been known that introduction of a wild plant species into cultivation induces variation. But the reason why some of the variations so induced were easily "fixed" while others were not remained unexplained until the discovery of Mendelian inheritance and the development of the science of genetics provided the necessary knowledge of heredity. It seems to have been the idea of many of the older writers on the subject of plant

TABLE I—*Pedigree of Pale Yellow Citrina Strain.*

P_1	C 2-17 (Fig. 16, A) 19"	X	C 9-16 (Fig. 16, B) 15"
	Ridgway No. 22 ?	:	lemon yellow (R,23)
	16.8 -- 7 plants - 4 lemon chrome: 2 lemon yellow: 1 pale lemon yellow		
F_1	P_2 (Fig. 16, C) 15"	X	P_6 (Fig. 16, D) 6"
	lemon yellow (R,23)	:	pale lemon yellow (R,23b)
	17.44 -- 3 plants lived - 2 lemon yellow: 1 pale lemon yellow		
F_2	P_4 (not illus.) 13"	X	P_2 (not illus.) 12"
	pale lemon yellow (R,23b)	:	lemon yellow (R,23)
	20.88 -- 8 plants - 1 R,22: 4 R,23: 3:R,23d		
	P_8 (Fig. 16, E) 8"	---	P_7 (Fig. 16, F) 6"
	lemon yellow (R,23)		picric yellow (R,23d)

Height of plant is stated in inches after number of illustration. Ridgway's No. 22 is intermediate between lemon chrome and lemon yellow; lighter tints than lemon yellow are pale lemon yellow (23b), picric yellow (23d), and martius yellow (23f), with 23c and 23e unnamed.

improvement that the horticulturist's art could, in some mysterious way, "break the type" or cause variation. In the case of these wild tarweeds it is very clear that the cause of the striking variations which appeared in the very first garden cultures are fully explained by the simple fact that the individual plant is self-sterile. It is probable that many problems in practical plant improvement would be simplified by a preliminary study of the plant itself, especially its provision for sexual reproduction.

During the first four years that these tarweeds were under cultivation many of the types of abnormality common among species long domesticated have been discovered. In the case of ornamental plants some of these abnormalities would be considered to be improvements, and they might be thought to be modifications induced by cultivation, but their presence in the first garden cultures or appearance after only one, two or three years of inbreeding shows that they are merely recessive characters which are represented in the germ cells but are seldom displayed by the wild plants which are cross-pollinated and hence heterozygous. The occasional appearance of such abnormal types even among wild plants would be due to the chance meeting in fertilization of two germ cells bearing the recessive factors for the abnormality. This may also explain the occurrence of such forms among the seedlings of cross-pollinated garden plants.

The demonstration that there is a genetic basis for such characters as plant size, plant habit and time of maturity is of some significance in taxonomy where the tendency may be strong to assign all such variations to ecological factors.

A Scottish Cattle Breeding Conference

There is to held a conference of cattle breeders at the University of Edinburg, on July 7-11. This conference will be chiefly for the purposes of reviewing the recent advances in our knowledge of breeding; to make a comparative study of breeding systems, breeding theories, and practice; to consider breeding problems; and to survey cattle breeding practice in other countries. The application of genetics to the problems of the practical breeder will be given special attention. In fact, the keynote of the meetings would appear to be the need for a closer linking of science and practice in the breeding of cattle.

Papers will be presented by leading breeders and geneticists in the British Isles and from other countries. It is planned to edit the proceedings of the conference and publish them in book form. This volume should be an authoritative guide for practical breeders and students of genetics, as it will give a summary of the status of scientific breeding throughout the world today.

The conference will be held during the week intervening between the Royal Livestock Show and the Highland Show. Breeders who expect to visit the British Empire Exhibition during the summer are urged to attend these meetings, which are being held under the auspices of the Animal Breeding Research Department of the university.